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Rural non-farm engagement and agriculture commercialization in Ghana: complements or competitors?

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Abstract

This paper studies the relationship between non-farm activity and agricultural market engagements. Precisely, we use endogenous switching probit and the generalized structural equation model (GSEM) to assess respectively the effect of non-farm participation on the decision to sell and on the level of commercialization of agricultural produce in Ghana. For this study, we use the Ghana Living Standards Survey for the years 2012/13. We find that non-farm participation consistently increases the probability of selling crops and the quantities sold. We conclude that non-farm engagement by farmers boosts market participation and levels of commercialization in Ghana, implying that non-farm engagement and agricultural commercialization are complements. Developing the agricultural sector thus requires the government to pay attention to creating conditions that would stimulate participation of farmers in non-farm activities.

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

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List of abbreviations

1D1F	One District One Factory
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
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
KG	Kilograms
METASIP	Medium Term Agriculture Sector Investment Plan
NFE	Non-Farm Engagement
OLS	Ordinary Least Squares
RNFE	Rural Non-Farm Economy
SEM	Structural Equation Model
UNCTAD	United Nations Conference on Trade and Development

Tables and figures

1. Introduction

Ghana is largely an agrarian economy with the business of agriculture significantly dominated by smallholder farmers who are predominantly rural dwellers (Ghana Statistical Service [GSS], 2014). Majority of the population in developing countries is rural (IFAD, 2011; UNCTAD, 2015) and their predominant livelihood activity is farming. Efforts therefore to lift these rural households from poverty and to set them up on the pathway of development has been narrowed to the policy measure of promoting the development of agriculture (UNCTAD, 2015; Ellis & Biggs, 2001; Haggblade, 2007). While this view is not entirely flawed, especially in the past decades, it is becoming obsolete in the advent of a fast developing rural non-farm economy (RNFE) in recent times. Most rural households engage in a range of economic activities other than just farming (UNCTAD, 2015). Some studies (e.g., de Janvry & Sadoulet, 2001; Buchenrieder et al., 2010) have attributed the growth of the RNFE to decreasing access to farmlands and the need for diversification of risks. In addition, agricultural shocks emanating from poor yields due to climate change and decline in land fertility are reasons for the rapid growth of the RNFE. These reasons are summarized by UNCTAD (2015) with their terminology of entrepreneurship by choice, by necessity and risk management. Other literature (see, e.g., Barrett et al., 2001; Reardon et al., 2007) have coined the terms demand-pull and distress-push as a way of describing the diversification of farm households into non-farm economic activities.

Given that the bulk of agriculture is dominated by smallholders, the rapid transformation of the agricultural sector due to the rising importance of RNFE should be a major concern to policy makers, scholars and development institutions. This is borne out of the fact that though the RNFE is usurping the role of agriculture especially in the agenda of economic transformation of the rural economy, agriculture still remains important (UNCTAD, 2015). In response to this, the areas of farm and non-farm sectors have received and gained wide currency, manifesting, for example, in the depths of empirical studies on the linkage of these two sectors.

The extant literature has demonstrated the existence of some linkages between the rural farm and non-farm sectors. First, we find some studies on the link between non-farm activities, income inequality, poverty reduction and welfare (see, e.g., Reardon & Taylor, 1996; Reardon et al., 1998; Mollers & Buchenrieder, 2011; Senadza, 2011; Dirven, 2011; Dzanku & Sarpong, 2014). The conclusions have not been robust. Second, there is literature linking non-farm activities to productivity, efficiency and cost complementarity (see, e.g., Anriquez & Daidone, 2010). A third class of studies links non-farm activities to expenditures on agricultural inputs, food crop investments and food security (see, e.g., Dedehouanou et al., 2016; Babatunde & Qaim, 2010; Smale et al., 2016).

Despite these contributions in the farm-non-farm discourse, the area is still evolving. One area that is surprisingly under-developed is exploring non-farm and farm linkages from the perspective of market participation and agricultural commercialization. Yet, the subject matter of market participation has been identified as one of the growth poles of poor rural households. For example, Yaro et al. (2017) underscore the importance of farmers engaging in both wage employment and farming as an important livelihood diversification strategy in Ghana. As a result, this has generated policy interests among individuals and institutions. Emphasizing the importance of market participation, and realizing that the literature is shy of its link to non-farm sector exposes an unmistakable gap. Two notable contributions in this regard are the studies of Kan et al. (2006), and Tudor and Balint (2006). However, these studies are plagued with some weaknesses. First, Kan et al. (2006), by exploring the effect of non-farm income on commercialization, concentrate on only farmers who engaged in non-farm work while ignoring

those who did not engage in non-farm work. The concentration on only farmers who engaged in non-farm work could lead to selection bias and also may limit the policy application of their findings. The current study will overcome this by incorporating all farmers in the analysis whether they are engaged in on- or off-farm. Second, Tudor and Balint (2006) merely explore correlation between off-farm work and commercialization to the neglect of methodology exploring causal effect. Thus, the approach is highly qualitative.

We note that part of the literature exploring the effect of non-farm engagement on productivity, efficiency and agricultural investments/expenditures draws an implicit weak conclusion: gains in agriculture (through these dimensions) lead to market participation. But this assumption might not be tenable. To address this lacuna, this study aims to provide responses to the following questions:

1. Does non-farm engagement by farm households promote selling of their farm output (market participation), and how?
2. How does the non-farm engagement influence the quantity sold (level of commercialization)?

Answering these questions has policy implications for Ghana and developing economies as a whole. Though the agricultural sector is declining in importance, its contribution to the economy in terms of GDP and employment cannot be written off. Thus, appropriate policy measures are needed from findings germane to the goal of this study. Evidence of the relationship between non-farm engagement and market participation, and the level of commercialization are key microeconomic policy ingredients that can play into sound and evidence-based policy in the area of the ever expanding farm-non-farm nexus.

This study contributes in exploring the relationship between farm and non-farm sectors from the perspective of decision to sell and the quantity sold (level of commercialization) in a manner that methodologically differs from the studies of Kan et al. (2006), and Tudor and Balint (2006) by first developing a theoretical model of agricultural commercialization of rural households in developing countries, and second, on the basis of this model, derive estimates of the main factors that determine their extent of agricultural commercialization. The specific objectives are to estimate the effect of non-farm engagement on decision to sell and the level of commercialization. Notable empirical evidences in the farm-non-farm linkage in Ghana are Anríquez and Daidone (2010), Dzanku and Sarpong (2014), Osarfo et al. (2016), Senadza (2011) and Owusu et al. (2011). However, as noted earlier, none of these studies has taken a dimension in the spirit of this current study. For example, Anríquez and Daidone (2010) examined the effect of non-farm engagement on input demands, production efficiency and cost complementarities. Dzanku and Sarpong (2014) focused on the effect of non-farm activities on two proxies of welfare: wealth and food security.

The current study uses the Ghana Living Standards Survey round 6 (GLSS6) dataset collected in 2012/13 to explore the relationship between non-farm participation and agricultural commercialization. The endogenous switching probit was used to estimate the effect of non-farm participation on the decision to sell while the generalized structural equation model (GSEM) was used to estimate the effect of non-farm participation on the quantity sold. The highlights of the results are that non-farm participation increases the probability of selling agricultural products and the level of commercialization. Thus, non-farm participation complements agricultural commercialization. The rest of the study is organized as follows. The review of literature is covered in section two. The methodology is presented in section three. Empirical results and discussions are then presented in section four and followed by conclusion and policy implications.

2. Literature review

The theoretical underpinning for studies on the relationship between farm and non-farm sectors has largely been the Singh et al.'s (1986) farm household model. Regarding labour allocation decisions, it posits that given households' skills, they allocate labour and other resources to specific activities with highest return such as non-farm employment. Thus, farm households' involvement in non-farm work is dependent on their human and physical capital endowments (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' factors (Barrett et al., 2001; Reardon et al., 2007). Households may be pulled into non-farm work if it has a higher return to labour or capital and is less risky compared to on-farm work (Kilic et al., 2009). Also, households 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 and loss of landholdings) which may threaten their welfare and food security situation (Woldehanna & Oskam, 2001; Holden et al., 2004).

On the determinants of participation in non-farm work, the literature in this area concludes that characteristics of households including education, ethnicity, skills and gender; assets, financial and social capital; and physical infrastructure and information remain important. Ackah (2013) reported land size, education and gender as determinants of non-farm work in Ghana. In a similar vein, Benedikter et al. (2013) observed that education, level of savings, prior work experience and social capital are the main drivers of non-farm work in Vietnam. In a study on the determinants of non-farm work in Nigeria by Olugbire et al. (2012), they identified education, household size, gender and land as critical for engagement in non-farm wage employment, whereas engagement in non-farm entrepreneurship is determined by access to credit, value of assets, land size and social capital. von Braun et al. (1991) argued that a higher wage rate in the off-farm sector will reduce farm output. Thus, a higher wage will see labour shifting into off-farm activities and hence less time is spent on farm activities.

Conceptually, effect of non-farm activities is based on four main arguments: the liquidity-relaxing effect, lost-labour effect, consumption and welfare effects, and market participation and commercialization effects (Reardon et al., 1994; Woldehanna, 2000; Woldehanna & Oskam, 2001; Babatunde, 2015). The liquidity-relaxing effect argument is related to the view that income from non-farm activities increases the average household income, thereby easing households' capital and credit constraints and increasing their capacity to purchase farm inputs and adopt new production technologies. This enhances households' farm productivity, efficiency and income. However, if non-farm income is spent on consumption and other non-farm investment rather than on farm inputs, then farm productivity growth may be affected negatively (Babatunde, 2015). Regarding the lost-labour effect, it is postulated that engagement in non-farm work places constraints on household labour for farm operations, which may adversely affect farm productivity. Thus, expansion of non-farm employment can lead to labour transfer out of farming and time spent on farming activities, which may reduce the adoption of labour-intensive agricultural technology, farm productivity and efficiency (Omiti et al., 2009).

On the consumption and welfare effects of non-farm sector, it is hypothesized that income from non-farm employment may supplement that from on-farm, thereby improving households' liquidity situation or serving to ease their budget constraints, smoothing their consumption, and equipping them with better coping strategies in times of sudden adverse conditions (Matshe & Young, 2004). Regarding the market participation and commercialization effects, conceptually, it is hypothesized that engagement in non-farm work may encourage smallholders' market participation, and thus commercialization if used as a liquidity source for investment in the farm;

which may enhance yield and marketable surplus (Woldehanna, 2000). On the other hand, if the non-farm income is used for consumption and other non-agricultural investment instead of farm investment, then non-farm work becomes a competitor rather than a complement to commercialization. This is because non-farm work may compete with on-farm work for labour and other resources, a situation which, in turn, lowers production and marketable surplus. However, there are limited empirical studies on the effect of non-farm work on smallholder market participation and commercialization (Woldehanna et al., 2016). A few exceptions are Kan et al. (2006) who find farm output to positively affect market participation while non-farm income negatively affects it; and Tudor and Balint (2006) who identify a positive correlation between off-farm employment and agricultural commercialization.

The preceding review brings to the fore that conceptually, the impact of non-farm activities on agricultural productivity and market participation is indeterminate based on the liquidity-relaxing effect, lost-labour effect or whether non-farm work competes or complements on-farm activities. Regarding household non-farm activities effect on welfare and consumption, the literature in this area concludes there is a positive effect (Holden et al., 2004).

On the empirical front a number of studies have investigated the linkage between on-farm and non-farm sectors. First, on the effect of non-farm on agricultural commercialization, Abdullah et al. (2017) found income from off-farm activities to increase the probability of household participation in the market. Other variables that were found to impact positively on market participation include household size, age and gender. However, Woldehanna et al. (2016) observed no effect of non-farm earning on market participation in Ethiopia. Riwthong et al. (2017) found pesticide application to significantly influence agricultural commercialization in Thailand. Chang et al. (2017) reported that husbands' non-farm labour decision positively affects marketing while the reverse is observed for farm wives. Lerman (2004), in a comprehensive review of factors influencing agricultural commercialization among countries in transition (from subsistence to commercialization) identified farm size, farmers' union and marketing services crucial to farmers' decision to commercialize. They argued that a larger farm size will mean a greater output and hence increase in marketable surplus. The availability of marketing support services such as input supply and marketing channels, they observed, could impact agricultural commercialization. Imai et al. (2016) examined the effect of agricultural transformation on poverty and inequality in Asia and the Pacific, and observed agricultural commercialization to increase agricultural productivity and also reduce poverty. In a recent cross country study involving Uganda, Tanzania and Malawi, Carletto et al. (2017) examined the nexus between agricultural commercialization and nutrition and made some significant findings. They found higher output to be associated with higher level of commercialization. Another striking contribution was the finding that though female headed households tends to participate less in the market, their level of commercialization, when involved in the market, tend to be higher than that of male headed households.

Second, other studies focused on the effect of non-farm engagement on income inequality, poverty reduction and food security (see Alemu & Adesina, 2017; Seng, 2016; Hoang et al., 2014; Owusu et al., 2011); effect of non-farm engagement on expenditure/investment on agricultural inputs, and food crop investments (see Dedehouanou et al., 2016; Smale et al., 2016; Babatunde, 2015; Maertens, 2009); effect of non-farm effect on agricultural productivity, efficiency and cost complementarity (see Anang, 2017; Yang et al., 2014; Pfeiffer et al., 2009; Woldehanna, 2002).

The review reveals that comparatively, studies on non-farm and farm linkages from the perspective of market participation and agricultural commercialization is limited. The few studies (Kan et al., 2006; Tudor & Balint, 2006; Woldehanna et al., 2016) are either merely descriptive or concentrate on farmers who participated in non-farm activities. This study departs from these

previous studies by adopting the GSEM which allows for examining farmers who engage in non-farm activities and those who do not while at the same time correcting for potential endogeneity, censoring of the commercialization variable and selectivity bias.

3. Methodology

3.1 Theoretical framework

In general, the Ricardian trade theory (see Ricardo, 1817; Barrett, 2008) is the underlying theoretical basis of farm households' engagement in the market to sell their produce. Farmers engage in the market principally to derive various bundles of consumption and welfare by specializing in the production of products for which they have comparative advantage and exchange these products for those they do not have comparative advantage.

However, in specific terms, this study is underpinned by Barrett's (2008) household non-separable commercialization model. The fundamental assumption of this model is that the quest for households to commercialize is premised on the decision to maximize their utility from engaging in the market. Thus, households dedicate a proportion of their produce to market in order to derive this utility. The proportion of sales, mostly measured by the ratio of sales, RS is fundamentally influenced by marketable surplus generated by a farm household, MS, a vector of transaction costs and other sales determinants, OS, and a vector of basic household specific characteristics, BHC. This fundamental relationship is specified as:

$$RS = f(MS, OS, BHC) \tag{1}$$

The MS is considered as the excess of household production, Q_p over the amount of household consumption, Q_c and thus:

$$MS_i = Q_{pi} - Q_{ci} \quad \text{and} \quad f'_{Q_p} \geq 0;\ f'_{Q_c} \leq 0 \tag{2}$$

where i represents a particular crop, and thus given the number of crops, $i, \ldots, n$, $MS = \sum_{i=1}^{n} MS_i$. A household is expected to sell only if $MS > 0$. By extension, Q_p and Q_c are critical predictors of RS.

Proposition 1: *Farmers sell a higher quantity if Q_p is sufficiently large*. On the basis of proposition 1, we set a corresponding hypothesis as: $\frac{\partial RS}{\partial Q_p} > 0$.

Given a typical farm household, Q_p, a typical supply function[1], is basically determined by the availability of privately held assets, PA (such as capital and labour) which are primarily assumed to be supplied by the household (Seng, 2015; Barrett, 2008), public goods and services, PG (such as extension and access to credit), price of the product, PX, price of inputs, P_r and BHC. This functional relationship is represented as:

$$Q_p = g(PA, PG, PX, P_r, BHC) \tag{3}$$

The basic endowment of capital is land cultivated while that of labour is family size and number of active members working on-farm. This implies that, eq. (3) would have land size, household size

[1] This typical supply function is derived from a multi-output profit function through Hoteling's lemma. Thus, the farmer's problem from first principles is a multi-output profit function conditioned by output prices, input prices and quantities of fixed inputs and subject to some constraints such as plot size, crop rotation patterns, etc.

and active members working on-farm as predictors of RS.

Proposition 2: *Farmers with more endowments of PA (i.e., larger household and farm sizes) would sell more quantities*. Thus, the hypothesis to be tested is that, $\frac{\partial RS}{\partial PA} > 0$.

On the other hand, Q_c, a typical demand function, is determined by household composition, HC, household habit or preferences, HB, income, Y, commodity prices, P_c, and expressed as:

$$Q_c = h(HC, HB, Y, P_c) \quad (4)$$

These variables should thus enter the model of eq. (1) as explanatory variables. One key proxy of household composition is the adult equivalent scale, AES, which can well represent the household food needs.

Proposition 3: *Farm households with higher adult equivalent scales are less likely to sell higher quantities. Thus, the* hypothesis to be tested is that, $\frac{\partial RS}{\partial AES} < 0$.

The commercialization literature (see, e.g., Cazzuffi & McKay, 2012; Alene et al., 2008) has placed much emphasis on the role of transaction costs and other sales factors in the selling behaviour of farm households. Critical transaction cost factors are roads, $MTRD$ and availability of transport, $PTPASS$. In addition to these transaction costs variables other sale variables such as radio, $RADIO$, availability of established markets, $COMMMKT$, and access to financial products, $BANK$ are key factors in commercialization. Therefore, these proxies are included in the RS model to identify their effects. We expect the coefficients of these variables to exhibit positive effects on RS.

In general, RS is a composite function comprising household production and consumption, transaction costs associated with agricultural commercialization and other socio-economic characteristics of the household, and expressed as:

$$RS = f(Q_p, PA, PG, PX, P_r, Y, P_c, AES, MTRD, PTPASS, RADIO, COMMMKT, BANK, BHC) \quad (5)$$

Given the objective of the study, controlling for the effects of these factors in eq. (5) provides the foundation for appropriately estimating the effect of non-farm engagement, NFE on RS. Therefore, eq. (5) is extended by incorporating NFE to obtain:

$$RS = f(Q_p, PA, PG, PX, P_r, Y, P_c, AES, MTRD, PTPASS, RADIO, COMMMKT, BANK, BHC, NFE) \quad (6)$$

On the basis of eq. (6), two counter propositions – the main concern of this study – can be drawn. Proposition 4a: *Controlling for all relevant covariates, farmers with NFE would sell higher quantities if NFE relaxes liquidity constraints and facilitate market networks.* From this, a corresponding hypothesis to test is stated as: $\frac{\partial RS}{\partial NFE} > 0$.

Proposition 4b: *Controlling for all relevant covariates – except farm-labour time – farmers with NFE would sell lower quantities if NFE reduces agricultural labour time and production.* From this, the hypothesis to test is stated as $\frac{\partial RS}{\partial NFE} < 0$.

Theoretically, the decision of a farmer to engage in non-farm activity is represented by the function:

$$U(RF, RoF, Ls) \quad (7)$$

where RF, RoF and Ls represent the utility derived from the returns from on-farm labour, non-farm labour and leisure respectively. Obviously, maximizing this utility function is done under the different constraints of, for instance, wages, prices, the household assets, etc. We expect that a farmer would choose to engage in non-farm if $U'(RoF^*) = U'(RF^*)$ and $RoF^* > 0$. The total time available per day, TT is 24 hours and this would be allocated to on-farm, non-farm and leisure. Thus TT is expressed as:

$$TT = k(TF, ToF, TLs) \quad (8)$$

where TF, ToF and TLs respectively represent the time allocated to on-farm, non-farm and leisure and depend on on-farm wage, WF, non-farm wage, WNF, and BHC. The respective functions are presented as:

$$TF(WF, WNF, BHC) \quad (9)$$
$$ToF(WF, WNF, BHC) \quad (10)$$
$$TLs(WF, WNF, BHC) \quad (11)$$

The implication of eq. (9)-(11) is that the wage from on-farm and non-farm should be controlled for in an NFE model. Given the variables in the RS model[2] and the wage rates, NFE model can be stated as:

$$NFE = m(Q_p, PA, PG, AES, PTPASS, RADIO, BANK, BHC, WF, WNF) \quad (12)$$

Proposition 5: *Farmers who are faced with higher on-farm wage (agricultural wage) are less likely to engage in non-farm activities*. Thus, we test the hypothesis that $\frac{\partial NFE}{\partial WF} < 0$.

3.2 The econometric specification

In what follows, we present the appropriate econometric specification according to the study problem, the theoretical model and the nature of the data at our disposal. The decision to sell agricultural products will depend on a set of the explanatory factors as noted in the theoretical model. Here, we denote these variables as X except NFE. The observed ratio of sales of household j, RS_j is zero if the household decides not to sell. For a household which decides to sell, $RS_j > 0$. However, if a household sells all the produce, $RS_j = 100$. The two extreme scenarios, $RS_j = 0$ and $RS_j = 100$, are similar to the case where we have a censored dependent variable while the explanatory variables are observed. We denote the continuous latent variable (without censoring) by $RS_j^{\because}$.

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

$$RS_j^{\because} = X_j\beta + \theta NFE_j + \epsilon_j \quad (13)$$

and

$$RS_j^{\because} = \begin{cases} RS_j & \text{if } RS_j^{\because} > 0 \\ 0 & \text{if } RS_j^{\because} \leq 0 \end{cases} \quad (14)$$

[2] Not all the variables in the RS model are applicable in the NFE model.

In the case where NFE is a random process, the Tobin (1958) model or the Tobit econometric specification is the appropriate model to estimate the treatment effect denoted by the parameter θ. However, NFE is not a random decision. Smale et al. (2016) and Dedehouanou et al. (2016) note the non-randomness of the discrete decision of farm households to participate in the $RNFE$. For example, households that are closer to towns are more likely to have the opportunity to engage in non-farm activities and to also sell their produce. Again, households with financial capability can easily travel to towns to engage in non-farm activities or to sell their produce. In addition to these, in real life, there are a set of unobservable factors, which can influence jointly the decision to have the non-farm activity and the proportion of sales. These generate selection bias and endogeneity. Thus, the econometric specification must consider two types of bias correction. The first is the censoring bias and the second is the selection bias. An appropriate way to treat jointly these two problems is to construct a Generalized Structural Equation Model (GSEM) (see, for instance, Drukker, 2016 and Skrondal & Rabe-Hesketh, 2004).

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

$$Z_j\gamma + \xi_j > 0 \tag{15}$$

where Z_j is the set of the determinants of the NFE decision. We assume that the error terms of eq. (13) and eq. (15) follow normal distributions:

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

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

and their correlations given as:

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

Under the SEM structure, the Heckman selection model is re-cast to two-equations – a linear regression (for the continuous outcome, RS) and a censored regression (for the selection equation, NFE) – and with a latent variable L_i added to both equations. We constrain the latent variable to have a variance of one in both equations and to have a coefficient of one in the selection equation, leaving only a coefficient, κ in the continuous-outcome equation to be estimated. For identification, the variance from the censored regression will be constrained to be equal to that of the linear regression after updating the left censoring ($RS_i^* = 0$) and the 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 enables for carrying the correlation between the two equations.
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

   $\beta = \beta^*$,

   $\gamma = \gamma^*/\sqrt{\sigma^{2*} + 1}$,

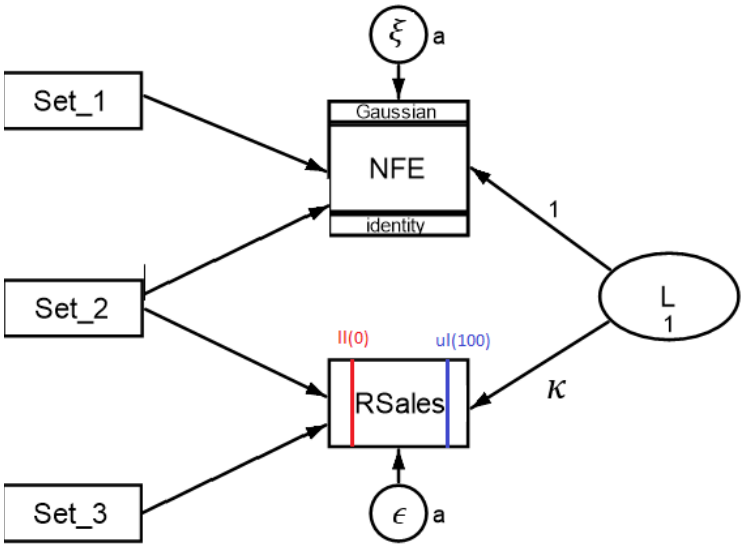
   $\sigma^2 = \sigma^{2*} + \kappa^2$

   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 we can observe 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). The estimation of this model is performed using the ***gsem*** command (in Stata Version 15.1).

However, this econometric procedure does not deal with the situation of measuring the effect of NFE on the decision to sell (which is a binary decision – either a farmer sells or not). The mathematical representation of the link between market participation and NFE can be specified as:

$$MP_j = f(X_j, NFE_j) \tag{16}$$

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 like the case above, the decision to engage in NFE and the decision to sell (MP) are potentially endogenous. Farm households may engage in non-farm activities to raise income for investments in farm activities such as purchase of inputs that could culminate in producing beyond consumption needs to participate in markets. Due to the potential simultaneous nature, modelling these two decision processes with univariate probit models would lead to biased and inconsistent estimates.

One notable econometric procedure that embraces, first, the potential endogenous nature of MP and NFE and second, the discrete nature of the outcome variable (i.e. MP) is the user written command *switch_probit* by Lokshin and Sajaia (2011). This model proposes a switch in the outcome (MP) based on treatment status (NFE) and implements full information maximum likelihood to simultaneously estimate the binary selection and the binary outcome parts of the

model to yield consistent standard errors of the estimates[3]. After estimating the various parameters of the model, treatment effects (i.e. ATT, ATU and ATE) of NFE on MP are derived.

3.3 Data

The study used the GLSS6 household-level dataset. This dataset was collected by the GSS between October 2012 and October 2013. The purpose of the survey is to generate information on living conditions in the country. It used a questionnaire adapted from the World Bank's Living Standards Measurement Survey and covers a stratified and nationally representative, random sample of 16,772 households in 1,200 enumeration areas. The GLSS6 focuses on the household as the key socio-economic unit. Detailed information was collected on the demographic characteristics of households, education, health, employment, migration and tourism, housing conditions, household agriculture, household expenditure, income and their components and access to financial services, credit and assets. Other modules administered in the survey were the non-farm household enterprises, household access to financial services and governance, peace and security.

However, disaggregating the entire sample (16,772) based on crops cultivated showed that only five crops had large number of farmers cultivating them. These are maize, groundnut, rice, beans and sorghum. Thus, cereals (maize, rice and sorghum) and legumes (groundnut and beans) were heavily cultivated in the 2012/2013 production season and depict the situation of crop production in Ghana. The various samples of farmers who cultivated these crops are maize – 4,437; groundnut – 1,730; rice – 1,157; beans – 1,371; and sorghum – 997. Thus, this study analyses 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 crop	1 = if yes; 0 = otherwise
RS	Commercialization index	Ratio of sales value to output value
HHAGE	Age of household head	Years
AvHHAGE	Average age of household	Years
HHSEX	Sex of household head	1 = if male; 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
ONFARM	No. of active members in on-farm	Number of people
OUT_PC	Per capita output	Output in kg/household size
FSIZE	Farm size	Hectare
PRICE_KG	Price	Ghana cedi/kilogram
CRED	Access to credit	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	Motorable road to community	1 = if yes; 0 = otherwise

[3] Due to space consideration, the theoretical layout of the model is not presented here. This is neatly done in Lokshin and Sajaia (2011).

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

The emphasis is placed on deriving an aggregate dataset of all these crops. In combining these into an aggregate dataset, we found that maize is the basic crop cultivated and hence most households who cultivated groundnut, rice, beans and sorghum also cultivated maize. Thus, combining the various crop datasets would not yield a sample of 9,692 (i.e. an addition of all the crop samples) but 4,915. This implies that the final sample size this study used is 4,915 farmers.

The GLSS6 has emerged as one of the important and richest datasets on Ghana as it presents a comprehensive, reliable and up-to-date statistics and indicators to monitor and evaluate the impact of development policies and programs on the living conditions of Ghanaians. This is the primary justification for the use of this dataset. It is capable of meeting the objectives of this study. It has a broad section on non-farm engagements and agricultural production. Further, an earlier version of this dataset (that is GLSS4) has been used by some studies to investigate farm-non-farm linkages (see, e.g., Anríquez & Daidone, 2010).

4. Results and discussion

The section presents and discusses the findings of the study. The study sets out to answer basically two questions; whether non-farm engagement influences a farmer's decision to sell and also the farmer's level of commercialization. The results are accordingly discussed next.

4.1 Characteristics of sample

Table 2 reports the descriptive statistics of the variables used for the econometric estimations. Focusing attention on the outcome and treatment variables for all the crops, the results show that overall, only 32.5% of farmers engaged in non-farm activities. For the decision to sell, overall 61.1% of farmers sold at least a crop while 60.3% of those who sold engaged in non-farm activity as compared to 61.5% of those who did not engage in non-farm activity. In terms of the level of commercialization, overall, 28.2% of output was sold while 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 any non-farm activity. These confirm studies in Ghana that indicate that the level of agricultural commercialization is low (see IFAD-IFPRI, 2011).

To assess the regional distribution of key variables of interest, regional maps of population density, crop output and level of commercialization are presented in Figure 2. As shown in the first plate, Greater Accra, Ashanti and Central regions are the most densely populated regions. This is to be expected because of the urbanized nature of these areas. In plate two, output is highest in the northern part of the country (Upper West, Northern and Upper East) as well as Greater Accra. The result is also not surprising because maize which is a dominant crop in our sample is heavily cultivated in the northern part of the country. The level of commercialization which is a key outcome variable in the study is also captured in the third plate. Interestingly but not surprising, commercialization is higher in Greater Accra and Ashanti regions. Due to the urbanized nature of these areas, farmers are motivated by higher prices to sell more of their output as opposed to the northern part of the country.

Table 2: Descriptive statistics of variables

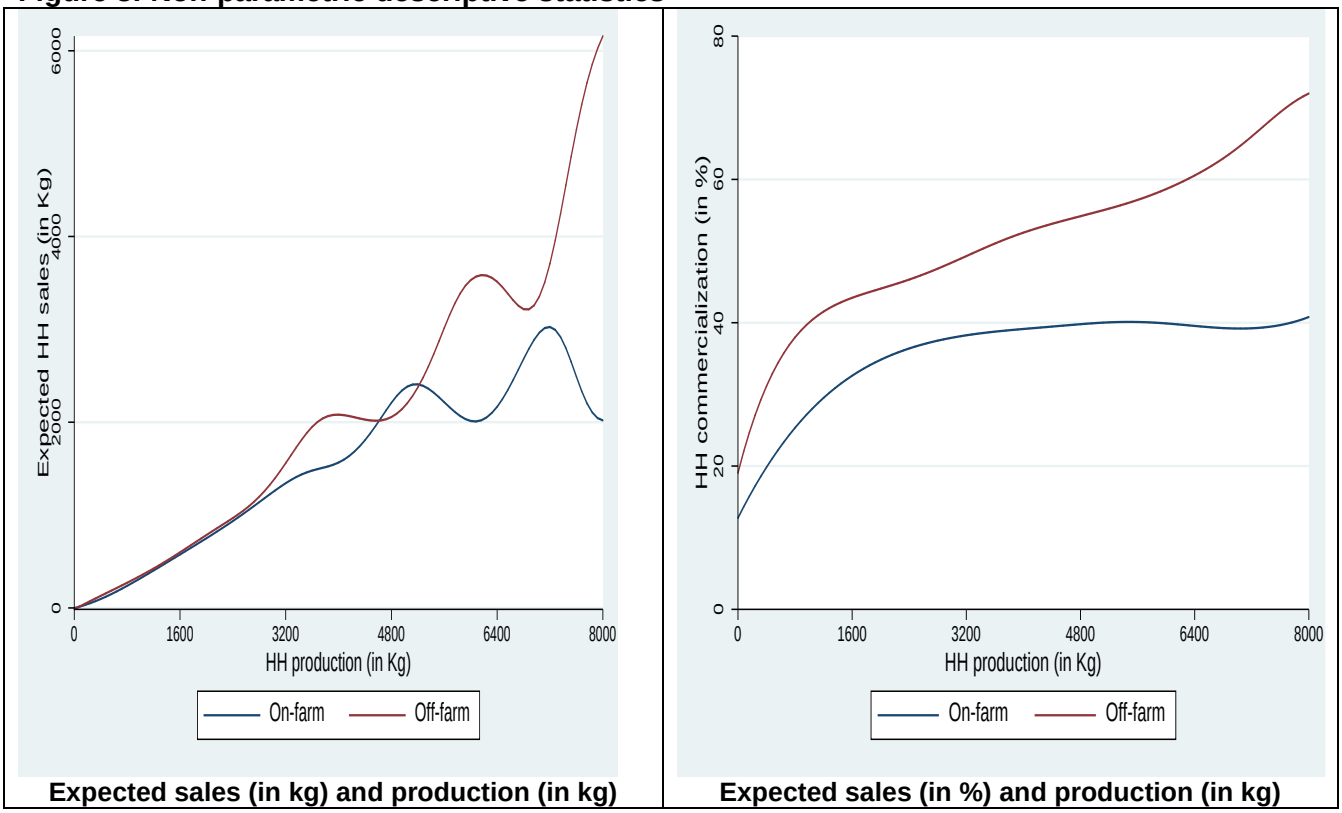
	NFE Participants (n = 1616)		NFE non-participants (n = 3299)		Overall (n = 4915)	
Variable	Mean[a]	S.D.	Mean	S.D.	Mean	S.D.
Non-farm engagement	-	-	-	-	0.329	0.470
Sold crop	0.603	0.489	0.615	0.487	0.611	0.488
Commercialization index	35.49	34.64	24.72	25.20	28.23	29.05
Age of household head	47.98	14.05	48.12	16.31	48.08	15.61
Average age of household	34.16	8.783	33.45	12.14	33.68	11.17
Sex of household head	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
No. of active members in on-farm	1.937	2.177	1.779	1.951	1.830	2.028
Per capita output in kg	243.6	766.3	286.2	635.7	272.4	681.1
Farm size in ha	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
Motorable 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] means for dummy variables are proportions/percentages for the '1' groups for the various variables; sampling weight is used

Figure 2: A map showing key variables of interest

We also present some non-parametric descriptive statistics of expected sales and the level of production.[4] These are shown in Figure 3. Generally, the figure indicates that the proportions sold in quantities (kg) and values (Ghana cedi) are increasing functions of the quantity produced. However, the non-farm group has higher sales as compared to their counterparts especially for the case of farmers with large production size. Further, more non-parametric descriptive statistics are presented in Tables A1 and A2 (in the Appendix). These statistics underscore the fact that, generally, households participating in non-farm activities in the higher deciles tend to produce more per capita and sell more than their counterparts not engaged in non-farm work. However, in total, households that did not engage in non-farm activities tend to sell more on average than those who engaged in non-farm activities.

Figure 3: Non-parametric descriptive statistics



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

4.2 Effect of non-farm engagement on market participation

The underlying estimates of the switch_probit endogenous regression model which presents the determinants of non-farm engagement and market participation are presented in Table 3. In addition to this, estimates for the individual crops are presented in Table A3 (in the Appendix) to check robustness.

The highlights of the results show that average age of the household, years of education, household size, price/kg, public transport availability and ownership of bank accounts increase the probability of engaging in non-farm activities while the number of active members in on-farm and agricultural wage reduce the probability of engaging in non-farm activities. Generally, these estimates meet a priori expectations. For example, the positive estimate of household size implies

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

that households with larger sizes are more likely to engage in non-farm activities since larger households require more financial resources to adequately meet basic household expenditures, and non-farm engagements provide an additional avenue for raising incomes to meet these expenditures besides incomes from on-farm activities. In addition, households with bank accounts are 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 centres exposes account owners to non-farm activities. Moreover, an increase in the level of education of the household heads increases their probability of engaging in non-farm activities since some level of education is a pre-requisite for securing jobs outside farming. Further, the negative estimate of the agricultural wage implies that an increase in the agricultural wage motivates farmers to stay on-farm rather than engaging in non-farm activities. A key motivation for non-farm engagement is to supplement the meagre earnings from agriculture particularly in developing countries. An increase in the agricultural wage therefore decreases the probability of engaging in non-farm activities.

Table 3: Determinants of non-farm activity and the decision to sell

Variable	NFE	Decision to sell	
		Participants	Non-participants
Basic household characteristics:			
Age of household head	-0.001	0.000	-0.006***
Average age of household	0.004**	-0.001	-0.001
Sex of household head	-0.033	-0.290**	0.142**
Years of education	0.035***	0.022*	-0.012*
Area of residence	-0.187	0.195	-0.001
Region:			
- Western	-0.492***	0.477**	0.880***
- Central	-0.029	5.407***	0.751*
- Greater Accra	0.162	0.698***	0.512***
- Volta	0.125	0.677***	0.442***
- Eastern	-0.142	0.344*	0.773***
- Ashanti	-0.078	0.454*	0.403**
- Brong Ahafo	0.047	0.665**	0.359*
- Northern	-0.065	-0.570*	-0.387**
- Upper East	0.556***	0.757***	0.056
Production determinants:			
Household size	0.119***	0.291***	0.116**
No. of active members in on-farm	-0.081***	0.080***	0.113***
Per capita output in kg		0.001***	0.001***
Farm size in ha	-0.008	0.045	0.053**
Price/kg	0.019***	0.060***	0.036***
Access to credit	0.045	0.644*	1.989***
Extension compliance		0.111	0.171***
Agricultural wage	-0.012**	-0.008	0.012*
Ecological zone:			
- Western	-0.040	0.178	-0.003
- Central	-0.366***	0.287	0.379**
Needs determinants:			
Adult equivalent scale		-0.325***	-0.200***
Other sales determinants:			
Market in community		-0.077	-0.355***
Motorable road to community		2.577***	0.382***

Public transport availability	0.174***	-0.056	0.083
Ownership of radio	-0.028	0.133	0.163***
Ownership of bank account	0.262***		
Constant	-0.960***	-2.722***	-1.194***
Observations		4915	
Wald chi2		528.20***	
Log Pseudo lik.		-5102.8090	
Rho		0.3069	-0.2280
Wald test		5.92*	

Source: Produced by the authors using the GLSS6 Data; * $p<0.1$; ** $p<0.05$; *** $p<0.01$

The results of the determinants of the market participation of participants and non-participants of non-farm indicate that except adult equivalent scale, household size, number of active members in on-farm, per capita output, price/kg, access to credit and motorable road in the community simultaneously positively determine the two regimes. Again, these estimates are generally consistent with expectation. For example, increase in output per capita increases the likelihood of selling since increasing output per capita provides the opportunity of generating marketable surplus to enter markets. Also, a higher price induces the probability of considering entering the market since a high price signal provides the incentive for generating marketable surplus. The infrastructure variable (motorable road) further shows that reducing transaction costs in agricultural marketing induces higher probability of selling.

From the estimates of the determinants of non-farm engagement and market participation, the treatment effects of non-farm engagements on market participation are predicted. The results of the predicted effects of non-farm engagement on market participation are presented in Table 4.

Table 4: Estimates of effect of non-farm engagement on market participation

	All crops	Individual crops[5]		
Effect		Maize	Groundnut	Rice
ATT	0.163	0.197	-0.398	-0.527
	(0.252)	(0.363)	(0.415)	(0.294)
ATU	0.121	0.310	0.342	0.650
	(0.269)	(0.387)	(0.391)	(0.236)
ATE	0.129	0.273	0.044	0.090
	(0.278)	(0.405)	(0.385)	(0.213)

Note: Figures in parentheses are standard deviations.

The results in Table 4 indicate that the estimated ATT for all crops and maize are positive and implies that non-farm engagement increases the probability of market participation. Specifically, market participation increases by 16.3% and 19.7% respectively for all crops and maize farmers who engaged in non-farm work. On the other hand, the estimated ATT for groundnut and rice are negative and imply that non-farm engagement of farmers reduces the probability of their participation in the market. In terms of the magnitude of effect, market participation decreases by 39.8% and 52.7% respectively for groundnut and rice farmers who engaged in non-farm activities. The negative estimates for these crops confirm the argument of lost-labour effect where non-farm engagement reduces the time that farmers invest in agricultural production. For example, Omiti et al. (2009) argue that expansion of non-farm employment can lead to labour transfer out of farming and time spent on farming activities, which may reduce the adoption of labour-intensive agricultural technology, farm productivity and efficiency. This subsequently leads to low

[5] Estimations for beans and sorghum do not achieve convergence.

production and thus low marketable surpluses for farmers to participate in the market. This observation either entirely contradicts the argument that non-farm engagement of farmers increases market networks, and thus facilitates the selling of their products or the effect of the time-loss in production outweighs the effect of market network facilitation.

The ATU estimates (which are the estimates from non-participants in non-farm activities) confirm the estimates of the ATT that non-farm engagement increases the probability of selling these crops. In terms of the ATE in Table 4, we find that consistently for all the crops, the ATE estimates are positive. Thus, non-farm engagement increases the probability of market participation. Specifically, market participation increases by 12.9%, 27.3%, 4.5%, and 9.0% 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 leading to increase in output and marketable surplus (Woldehanna, 2000). This contradicts the finding of Kan et al. (2006) who observe a negative effect of non-farm engagement on market participation in Georgia.

4.3 Effect of non-farm engagement on agricultural commercialization

The estimates of 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 are presented in Table 5. Before the estimation of 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 respectively in the second and third columns. 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 estimation of the OLS, the Tobit and the GSEM models reveals the extent and the nature of the different biases, as well as the importance of correcting them.

We focus on the parameters of the estimated baseline model. First, we find that the hypothesis with respect to quantity produced is confirmed. The coefficient is positive and statistically significant implying that increase in output leads to increase in marketable surplus and hence the quantity sold. Second, the hypothesis on consumption is also confirmed. The coefficient of the adult equivalent scale (which is a measure of household needs) shows a negative impact on commercialization. Thus, the greater the needs of the household in a form of consumption, the lower the quantity sold.

Most of the other determinants have their expected signs. Household size exerts a significant and positive effect on the level of commercialization. Within the context of a developing country, this is to be expected because members of a household largely serve as a source of labour for farming activities. An increase in household size means an increase in labour and consequently an increase in output. Increase in output results in increase in marketable surplus and hence the level of commercialization. A related variable which also positively and significantly impacts the level of commercialization is the number of active members engaged in farming. This is a refined measure of household labour as it covers only members within the active labour force. The greater the number of active household members in on-farm business, the greater the supply of labour and consequently output. Increase in per capita output leads to an increase in the level of commercialization.

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	**11.27*** **	**14.08*** **	**16.37*** **	
***Basic household characteristics*:**				
Age of household head	-0.106***	-0.176***	-0.177***	-0.0022
Average age of household	-0.0172	-0.0218	-0.0253	0.127***
Sex of household head	2.457*	5.666**	5.722**	-1.822
Years of education	-0.190	-0.330*	-0.367*	1.061***
Area of residence	0.481	0.0553	0.103	-1.327
Region:				
- Western	7.791**	3.643	4.030	-10.43***
- Central	15.35***	20.02***	20.90***	-25.19***
- Greater Accra	30.21***	38.70***	39.22***	-14.31*
- Volta	13.49***	16.55***	16.83***	-7.771***
- Eastern	16.35***	21.04***	21.32***	-7.436***
- Ashanti	19.53***	24.86***	25.43***	-15.35***
- Brong Ahafo	13.32***	16.68***	17.22***	-14.55***
- Northern	4.865***	7.219***	7.616***	-10.76***
- Upper East	-5.479***	-16.82***	-16.43***	-11.39***
Production determinants:				
Household size	1.447	3.105**	3.015**	2.551***
No. of active members in on-farm	1.344***	2.587***	2.647***	-1.596***
Per capita output in kg	0.0051***	0.0073***	0.0073***	
Farm size in ha	-0.0064	0.0160	0.0172	-0.0872
Price/kg	0.234**	0.568***	0.567***	0.0748
Access to credit	38.23***	52.09***	52.06***	0.624
Extension compliance	6.180***	10.42***	10.42***	
Agricultural wage	-0.0667	-0.0754	-0.0648	-0.297**
Ecological zone:				
- Western	-7.690***	-10.11**	-10.35**	6.533**
- Central	-8.231***	-11.55***	-11.71***	4.307*
Needs determinants:				
Adult equivalent scale	-2.804**	-5.894***	-5.893***	
Other sale determinants:				
Market in community	1.975*	1.938	1.934	
Public transport availability	1.503	2.916*	2.753*	4.743***
Ownership of radio	4.515***	6.700***	6.769***	-1.910*
Ownership of bank account	1.073	1.973	1.721	6.878***
Latent			-29.66***	1
Constant	11.07***	-4.402	-4.874	-18.91***
Observations	4915	4915	4915	4915
R^2	0.307			
Pseudo R^2			0.101	
σ^2		1346.6***	467.9***	
τ^2				467.9***

Source: Produced by the authors using the GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010

We also find that expectedly, complying with the instructions of extension officers and access to credit show positive effect on the level of commercialization. Extension officers are experts who teach farmers best farming practices with regard to land preparation, sowing, weeding, harvesting among others. By complying with their instructions and guidelines, a farmer is expected to increase his or her output leading to an increase in marketable surplus and consequently, a higher level of commercialization. In addition, farmers who accessed credit are expected to increase their investment in farming through the purchase of productivity enhancing inputs. An increase in farm investment should lead to an increase in output and hence an increase in quantity sold.

Access to information through ownership of a radio, has a positive impact on the level of commercialization. Access to radio serves as a means of accessing information on market, pricing, best farming practices and weather among others. The quality of information received could increase the level of commercialization.

Turning attention to the effect of NFE on commercialization, the results in Table 5 show that the treatment effect of NFE is positive and statistically significant in all the three models. This implies that NFE increases the quantity of output sold. Specifically, engagement in non-farm activities increases the quantity sold by 11.3%, 14.1% and 16.4% respectively for the OLS, Tobit and GSEM models. These models show different results in terms of the magnitude, and indicate that progressively, there is a downward bias from the OLS to the GSEM estimates. This bias type is expected. First, the OLS presents a downward bias to the Tobit because, farmers who did not sell any product had zero levels of sales, and since the OLS does not have the structure to correct for this massing-up at zero, the level of sales for the entire sample would be underestimated. However, the Tobit has the structure to correct this censoring issue and presents a higher estimate. Second, the Tobit also presents a downward bias to the GSEM because it adjusts the zeros to correct for the censoring, but it is unable to deal with the selectivity and endogeneity biases, which in this case cause underestimation. Since the GSEM corrects these two problems in addition to the 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) we find an understatement of the effect of NFE. Indeed, the on-farm group have relatively greater crops outputs (for instance, they have more land), and if this group participates in the non-farm activity, the impact of the quantity sold on average will be high. The corrected effect, thus, is the 16.4% given by the GSEM which controls for selectivity bias and endogeneity as well as censoring of the commercialization variable. This means that farmers who engaged in NFE sold 16.4% more output than their counterparts who did not engage in NFE. These observations confirm the assertion that non-farm engagement positively impacts commercialization. Hence, non-farm engagement can be described as a complement to commercialization.

A number of reasons can be attributed to the positive effect of NFE on commercialization. First, incomes earned from non-farm activities may be ploughed back into crop production. For example, these incomes can be invested in increasing land under cultivation and a corresponding investment in modern technology such as the purchase of productivity-enhancing inputs (see Babatunde, 2015; Smale et al., 2016; Dedehouanou et al., 2016). This increases production and subsequently marketable surplus. This confirms the liquidity-relaxing effect argument that income from non-farm engagement eases household capital and credit constraints thereby increasing their investments on farm inputs. Second, the engagement of farmers in non-farm activities stimulates market network and facilitates the selling of products. For example, non-farm participation provides farmers with information on market dynamics which in turn makes them comparatively better equipped to engage with the market.

As a way of robustness check, we also estimated the effect of NFE using the individual crops. The results are presented in Table A4 (in the Appendix). The results indicate that the treatment effect of NFE on maize and groundnut are all positive and thus confirm that the effect of NFE on commercialization is monotonically positive.

4.4 Heterogeneous effects of non-farm engagement on agricultural commercialization

The study also assessed whether there are heterogeneous effects of non-farm engagement across ecological zones, and interaction of ecological zones and localities of households. The results of this exercise are reported in Table 6 where only the outcome (commercialization) part of the GSEM is shown.[6] The treatment part (NFE) is presented in Table A5 (in the appendix).

Table 6: Agricultural product sales and off-farm activity by ecological zones and locality

	Ecological zone			Interaction of ecological zone and locality			
Variable	GSEM 1	GSEM 2	GSEM 3	GSEM 4	GSEM 5	GSEM 6	GSEM 7
Non-farm engagement	21.64***	20.86***	9.901	21.35***	11.51***	9.697**	20.88***
Basic household characteristics:							
Age of household head	-0.066	-0.055	-0.255***	-0.072	-0.258***	-0.259***	-0.066
Average age of household	0.020	-0.030	0.002	-0.036	-0.020	0.023	-0.031
Sex of household head	6.435**	5.650**	1.402	5.301*	1.337	2.967	5.752**
Years of education	-0.487	-0.458		-0.510*	-0.285	-0.174	-0.428
Area of residence	-4.799	-1.344	1.414			5.915	-2.046
Region:							
- Western	-12.52**	-9.737*		-10.03*		59.70***	2.593
- Central	4.907	5.152		4.555		26.14***	17.49*
- Greater Accra		25.55***		25.53***			37.92***
- Volta	2.206	-0.204	13.74***	0.765	14.28***	13.44***	12.80
- Eastern	2.814	3.256		3.163		39.95	15.74
- Ashanti	7.915*	7.460*		7.513*		32.79***	19.85*
- Brong Ahafo			15.76***		17.65***	15.84***	11.59
- Northern			7.288***		7.490***	7.087***	-0.785
- Upper East			-14.43***		-12.50***	-14.43***	-65.65***
Production determinants:							
Household size	1.612	1.443	3.865**	1.477	3.607**	3.803**	1.429
No. of active members in on-farm	1.065	0.597	3.806***	0.645	3.764***	3.732***	0.769
Per capita output in kg	0.008***	0.008***	0.007**	0.008***	0.007**	0.007**	0.008***
Farm size in ha	2.193**	2.024*	0.002	1.981*	-0.001	0.001	1.757**
Price/kg	0.227	0.944**	0.446**	0.924**	0.483***	0.458***	0.936**
Access to credit	54.36***	53.10***	40.54***	52.78***	40.74***	42.16***	52.81***
Extension compliance	15.02***	15.55***	6.198***	15.39***	6.238***	6.540***	15.09***
Agricultural wage	-0.364	-0.307	0.295	-0.315	0.327	0.206	-0.302
Needs determinants:							
Adult equivalent scale	-3.979	-3.634	-7.073***	-3.732	-6.765***	-6.900***	-3.662
Other sales determinants:							
Market in community	7.535***	9.305***	-4.551**	9.283***	-5.894***	-4.212**	9.754***
Public transport availability	-0.926	0.970	5.862***	0.866	6.293***	5.796***	0.702
Ownership of radio	12.40***	11.48***	1.538	11.67***	1.484	1.760	11.30***

[6] Due to low sample of households from coastal zone (263), estimation did not achieve convergence. We thus incorporated the sample into the forest sample to create a third sample in addition to the forest and savannah samples.

Ownership of bank account	1.309	2.038	0.901	1.683	0.637	1.763	2.158
Latent	-29.72***	-30.10***	-5.067	-30.50***	-26.85***	1.736	-30.18***
Constant	-3.999	-8.822	5.684	-8.273	7.705	-0.408	-19.76*
Observations	1555	1818	3097	1774	3012	3141	1903
σ^2	530.2***	518.9***	1142.8	494.2***	451.1***	1172.5***	493.8***

Source: Produced by the authors using the GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010; GSEM 1 is forest; GSEM 2 is forest/coastal; GSEM 3 is Savannah; GSEM 4 is interaction of forest/coastal and rural; GSEM 5 is interaction of Savannah and rural; GSEM 6 is interaction of forest/coastal and urban; GSEM 7 is interaction of Savannah and urban.

The results show that households in forest ecological zone sell more (21.6%) than those in both forest and coastal zone (20.7%) and Savannah zone (9.9%). This finding confirms the observation from the map in the third plate in Figure 2 where we observed that commercialization is high in southern Ghana which houses the forest and coastal ecological zones of Ghana as compared to northern Ghana which is the Savannah area. We explained that higher prices in the south incentivize households to sell more than in the north. With respect to the interaction of ecological zone and locality, the results indicate that households in rural areas of forest/coastal zone sell more (21.4%) than rural households in Savannah zone (11.5%) while households in urban areas in Savannah zone sell more (20.9%) than urban households in forest/coastal zone. The implication of these observations is that the effect of NFE on commercialization is highly heterogeneous across ecological zones and locality and thus calls for caution in the design and implementation of agricultural policies geared towards enhancing commercialization.

5. Conclusion and policy implications

The study analyzed the effect of non-farm participation by farmers on the decision to sell five crops (i.e. market participation) – maize, beans, groundnut, rice and sorghum, on the one hand and the quantity sold (level of commercialization) by farmers who made the decision to sell these crops on the other hand. Endogenous switching probit ("*switch_probit*") was used to estimate the determinants of non-farm engagement and market participation and on the basis of the parameter estimates, the effects of non-farm engagement on market participation were evaluated. For the level of commercialization outcome, 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 are evident from the analyses. First, non-farm participation consistently increases the probability of selling crops as indicated by the ATE. Second, non-farm participation increases the quantity sold. Third, commercialization varies markedly across ecological zones and locality of households. The conclusion of this study is that non-farm engagement by farmers encourages 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 subsistent to a commercialized sector through existing policies, stakeholders, primarily the government of Ghana, should rethink the implementation of these existing agricultural policies. Government has indicated the importance of commercialization and non-farm engagement in most policy documents. However, agricultural policies to achieve these are often implemented to run parallel. To achieve maximum impact, these policies should be revised to simultaneously tackle commercialization and non-farm work. For example, government's flagship program, "*Planting for Food and Jobs* (2017-2022)" and METASIP-III (2018-2021) tend to concentrate on increasing productivity, production and commercialization but nothing on encouraging non-farm work. We therefore recommend that government should insert promoting non-farm work in rolling out these policies. To promote non-farm work in these current policies, the government should concentrate

on broadening the capability of farmers to have access to financial capital, education and infrastructure. Second, in the formulation of new policies, the government should be guided by this complementarity evidence. Specifically, we recommend that the current "*One District, One Factory (1D1F)*" development agenda on the drawing table is a perfect opportunity to provide farm households openings for non-farm work.

Another line of maximizing the impact of agricultural policies is to ensure a policy design that would be responsive to the locality and ecological zones of farm households. Thus, adaptive-centred 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 which is a key policy objective of METASIP-III.

However, it is important to note that development of non-farm work should complement agriculture, and this could be achieved by making agriculture attractive to encourage farmers to invest in the sector. Thus policy should promote access to productivity-enhancing inputs since the majority of farmers live in rural areas where access to these inputs is poor. In addition, modern irrigation facilities should be provided to help stimulate all-year round production. This would enhance agricultural production and consequently a higher level of commercialization.

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Appendices

Table A1: Per capita agricultural product outcomes (in kg) and the proportion of sales (on-farm)

	All crops		Maize		Groundnut		Rice		Beans		Sorghum	
DECILE	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*
1	169.5	30.2	92.4	29.1	97.9	38.9	56.3	63.3	18.7	27.1	41.1	29.0
2	182.0	39.4	105.8	37.5	107.0	44.2	92.3	63.8	32.9	13.4	40.4	21.0
3	196.9	48.5	126.8	51.4	116.8	52.3	135.8	67.6	21.0	27.5	61.8	17.6
4	156.3	43.7	103.9	43.0	118.0	49.0	135.2	60.6	15.7	37.1	54.6	27.0
5	225.2	45.7	124.7	41.5	186.7	40.7	284.5	58.5	42.8	51.5	53.0	27.9
6	122.6	44.5	78.8	34.8	124.7	49.5	158.8	59.9	36.6	46.5	38.6	20.3
7	146.9	38.8	113.5	35.9	116.1	41.0	186.5	60.6	14.9	27.7	61.3	36.0
8	235.6	44.4	155.3	42.7	126.2	54.4	305.4	55.7	23.2	29.6	44.7	24.2
9	176.0	42.8	143.5	48.6	153.8	50.3	302.4	63.9	44.2	43.9	41.7	11.3
10	350.5	30.1	299.7	27.3	305.6	31.3	561.1	58.1	59.3	40.7	40.3	14.7
Total	202.1	40.8	141.4	39.1	150.3	45.2	232.6	61.0	31.1	34.6	47.5	22.5

Table A2: Per capita agricultural product outcomes (in kg) and the proportion of sales (non-farm)

	All crops		Maize		Groundnut		Rice		Beans		Sorghum	
DECILE	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*	*OUT_PC*	*% of sales*
1	198.2	29.0	141.4	24.2	75.1	47.2	44.6	26.9	24.9	28.5	48.0	10.1
2	213.8	39.7	153.4	36.2	88.5	41.8	67.4	31.0	44.6	43.9	67.9	12.6
3	268.2	34.3	187.0	30.9	96.3	50.9	46.6	32.2	31.6	35.8	43.8	23.0
4	240.6	38.0	161.4	31.2	80.4	55.3	61.3	28.9	46.4	30.3	32.8	17.8
5	180.6	35.7	129.0	31.9	113.8	49.1	60.6	33.6	47.5	30.8	63.4	7.8
6	195.2	38.7	141.9	34.1	58.0	52.8	67.7	25.9	44.2	52.6	52.2	8.8
7	215.5	37.6	151.5	28.6	86.6	34.0	63.6	24.3	51.0	39.1	26.8	19.9
8	222.9	37.7	155.4	33.3	91.0	53.4	103.1	36.6	70.6	40.7	37.2	35.9
9	292.1	45.2	225.1	42.2	104.5	55.9	59.8	18.8	53.2	53.5	46.4	20.2
10	318.5	42.3	225.5	36.7	116.2	50.1	119.8	38.6	97.3	49.7	65.1	28.0
Total	232.5	37.6	165.7	32.7	89.9	49.0	67.8	29.4	50.8	40.3	48.3	18.4

Table A3: Switch_probit estimates of determinants of non-farm engagement and participation

Variable	Decision to sell maize			Decision to sell groundnut			Decision to sell rice		
	NFE	PART	Non-PART	NFE	PART	Non-PART	NFE	PART	Non-PART
Basic household characteristics:									
Age of household head	-0.001	-0.002	-0.006***	-0.001	-0.003	-0.001	-0.004	0.004	-0.006**
Average age of household	0.004**	0.003	-0.000	0.006*	-0.001	0.005	0.004	-0.014**	-0.003
Sex of household head	0.006	-0.098	0.159**	-0.116	0.168	-0.077	-0.028	0.070	-0.078
Years of education	0.033***	0.028	-0.015**	0.010	-0.015	0.006	0.012	-0.022*	0.020*
Area of residence	-0.266**	-0.076	-0.086	0.095	0.347	0.132	-0.087	0.481**	0.248
Region:									
- Western	-0.514***	5.572	0.919***						
- Central	-0.316	0.100	0.711*						
- Greater Accra	0.189*	6.333***	0.385**						
- Volta	0.176	6.290***	0.369**						
- Eastern	-0.127	5.410***	0.727***						
- Ashanti	-0.057	5.942***	0.294*						
- Brong Ahafo	0.127	5.923***	0.166						
- Northern	-0.009	5.421***	-0.042						
- Upper East	0.677***	5.676***	-0.269						
Production determinants:									
Household size	0.123***	0.207*	0.010	0.134***	-0.077	0.116**	0.120***	0.188**	0.124**
No. of active members in on-farm	-0.073***	0.114***	0.112***	-0.093***	0.056***	-0.051**	-0.066***	0.098***	-0.011
Per capita output in kg		0.002***	0.001***		0.001***	0.003***		0.002***	0.005***
Farm size in ha	-0.040**	-0.097	0.131***	0.000	0.077	0.005**	0.217***	0.055	0.179***
Price/kg	0.012	0.053	-0.020	-0.020	0.050***	0.028	0.003	-0.025	-0.032
Access to credit	0.023	13.450***	7.311***	0.002	-0.009	-0.078	0.227	-0.128	0.111
Extension compliance		0.186	0.170***					-0.020	0.034
Agricultural wage	-0.010**	-0.017	0.015**	-0.019**	0.002	0.013	-0.010	0.081***	0.046**
Ecological zone:									
- Western	-0.056	6.468***	-0.029	-0.305	0.268	-0.352			
- Central	-0.392***	6.236***	0.124	-0.070	-0.011	-0.161			
Needs determinants:									
Adult equivalent scale		-0.252	-0.076		0.012	0.023		-0.393***	0.016
Other sales determinants:									
Market in community		-0.626***	-0.316***		2.124***	-7.229***		-0.257***	-0.059
Motorable road to community		20.531***	0.324***					-0.021	0.080
Public transport availability	0.184***	-0.986***	-0.001	0.187***	-0.291***	0.059	0.127	0.049	0.128

Ownership of radio	-0.003	0.029	0.126**	-0.064	0.135*	0.022	-0.084	-0.068	-0.124
Ownership of bank account	0.286***			0.181***			0.199**		
Constant	-0.895***	-14.152	-0.987***	-0.880**	0.193	6.242	-0.696**	0.534	-0.858**
Observation		4437		1730			1157		
Wald chi2		486.65***		147.97			97.57***		
Log Pseudo lik.		-4381.61		-1496.33			-1318.67		
Rho		0.5202	-0.3761		-1.00	1.00		-1.00	1.00
Wald test		17.15***		32.84***			8.46**		

Source: Produced by the authors using the GLSS6 Data; * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table A4: Determinants of non-farm engagement and commercialization

	Maize				Groundnut			
	Simple OLS		GSEM: Full model		Simple		GSEM: Full model	
Variable		Tobit	RS	NFE	OLS	Tobit	RS	NFE
Non-farm engagement	12.05***	15.64***	17.50***		8.797***	12.40***	14.64***	
Basic household characteristics:								
Age of household head	-0.095***	-0.199***	-0.200***	0.006	-0.065	-0.104	-0.103	-0.037
Average age of household	-0.012	-0.012	-0.014	0.126**	-0.092	-0.121	-0.128	0.192**
Sex of household head	2.002	5.856**	5.883**	-1.473	6.626***	11.37***	11.55***	-4.790*
Years of education	-0.113	-0.279	-0.307	1.209***	-0.190	-0.282	-0.296	0.329
Area of residence	-1.876	-4.982	-4.893	-3.725	5.535	10.39	10.28	2.956
Region:								
- Western	8.008***	13.08**	13.45**	-14.70***	9.706			
- Central	15.59***	31.19***	31.95***	-32.99***	25.63***			
- Greater Accra	28.56***	51.43***	52.03***	-24.89**				
- Volta	11.39***	22.86***	23.13***	-10.78***	14.23***			
- Eastern	15.94***	30.67***	30.92***	-9.855***	5.172			
- Ashanti	18.81***	34.22***	34.72***	-20.36***	0.421			
- Brong Ahafo	12.38***	23.11***	23.57***	-19.05***	-2.275			
- Northern	0.355	4.430	4.750*	-13.24***	4.015**			
- Upper East	1.790	2.459	2.820	-15.64***	-4.004**			
Production determinants:								
Household size	-0.159	0.228	0.154	3.155***	1.732	3.093	3.007	2.214***
No. of active members in on-farm	0.949***	2.369***	2.413***	-1.806***	2.501***	3.921***	3.986***	-1.57***
Per capita output in kg	0.003	0.006	0.006	-0.656	0.009**	0.012**	0.012**	
Farm size in ha	1.616***	2.869***	2.884***	0.112	0.218	0.249	0.244	0.107

Price/kg	-0.702**	-1.385**	-1.389**	1.024	-0.301	-0.411	-0.379	-0.852**
Access to credit	40.99***	58.96***	58.93***	3.155***	18.72***	24.20***	24.17***	0.733
Extension compliance	6.370***	12.14***	12.14***		25.10***	38.62***	38.62***	
Agricultural wage	-0.076	-0.017	-0.009	-0.346**	0.428**	0.569**	0.583**	-0.367
Ecological zone:								
- Western	-1.144	-0.447	-0.669	9.130**	9.008*	14.67*	14.66*	0.060
- Central	-2.404	-3.579	-3.740	6.278**	-4.118	-5.417	-5.148	-7.339*
Needs determinants:								
Adult equivalent scale	-0.879	-2.583	-2.583		-2.803	-5.124*	-5.127*	
Other sales determinants:								
Market in community	2.155*	1.826	1.822		-7.62***	-12.60***	-12.60***	
Public transport availability	0.702	1.725	1.584	6.156***	9.189***	11.98***	11.83***	3.650**
Ownership of radio	6.185***	9.838***	9.889***	-2.127	-3.002**	-4.799**	-4.794**	0.0001
Ownership of bank account	0.997	2.340	2.131	8.695***	0.764	0.100	-0.245	8.403***
Latent			-29.74***	1			-26.33***	1
Constant	8.273**	-17.91**	-18.35**	-20.67***	8.755	-12.56	-12.91	-18.9***
Observations	4437	4437	4437	4437	1730	1730	1730	1730
R^2	0.362				0.413			
Pseudo R^2			0.142				0.054	
σ^2		1592.6***	709.1***			1068.1***	375.9***	
τ^2				709.1***				375.9***

Source: Produced by the authors using the GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010

Table A5: Agricultural product sales and non-farm activity by ecological zones and locality

Variable	GSEM 1	GSEM 2	GSEM 3	GSEM 4	GSEM 5	GSEM 6	GSEM 7
Basic household characteristics:							
Age of household head	0.058	0.061	-0.097	0.069	-0.105	-0.065	0.061
Average age of household	0.126*	0.152**	0.147	0.140**	0.162	0.093	0.148**
Sex of household head	0.355	0.756	-9.991*	0.718	-9.706**	-6.760***	0.790
Years of education	1.516***	1.437***	0.887	1.417***	0.943***	0.610***	1.352***
Area of residence	-3.992	-0.049	-6.687		-12.41**		1.215
Region:							
- Western	6.339*	3.854		3.773	-252.7***		-28.49***
- Central	-18.87***	-12.76***		-11.70***	-58.97***		-44.69***
- Greater Accra		2.094		2.058			-30.40***
- Volta	9.086**	7.635**	-12.45	6.727**	-10.66**	-8.406***	-24.74***
- Eastern	7.842**	7.606**		7.428**	6.760		-25.10***
- Ashanti	-0.422	-0.689		-0.516	-267.0***		-33.30***
- Brong Ahafo			-20.21		-20.74***	-11.56***	-33.51***
- Northern			-14.48*		-15.06***	-8.273***	-29.82***
- Upper East			-18.05*		-18.69***	-10.40***	-39.85***
Production determinants:							
Household size	3.713***	3.559***	3.007*	3.420***	3.082***	1.855***	3.481***
No. of active members in on-farm	-2.096***	-2.164***	-1.839	-2.024***	-1.990***	-1.106***	-2.180***
Farm size in ha	-1.354*	-1.388*	-0.080	-1.311*	-0.0822	-0.0528	-0.889
Price/kg	-0.085	-0.092	0.378	-0.102	0.348	0.313**	-0.221
Access to credit	0.211	0.509	3.321	0.175	4.804	1.921	0.462
Agricultural wage	-0.512**	-0.379**	-0.301	-0.338*	-0.417	-0.121	-0.385**
Other sales determinants:							
Public transport availability	6.985***	6.824***	4.195	6.679***	4.024*	2.707*	6.525***
Ownership of radio	-3.610*	-3.230*	-0.757	-3.398**	-0.349	0.055	-3.539**
Ownership of bank account	5.504***	5.556***	16.11*	5.689***	16.07***	9.249***	5.945***
L	1	1	1	1	1	1	1
Constant	-35.48***	-40.69***	-11.04	-40.08***	-5.381	-12.23***	-7.776
Observations	1555	1818	3097	1774	3141	3012	1903
τ^2	530.2***	518.9***	1142.8	494.2***	1172.5***	451.1***	493.8***

Source: Produced by the authors using the GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010; GSEM 1 is forest; GSEM 2 is forest/coastal; GSEM 3 is Savannah; GSEM 4 is interaction of forest/coastal and rural; GSEM 5 is interaction of forest/coastal and urban; GSEM 6 is interaction of Savannah and rural; GSEM 7 is interaction of Savannah and urban.