

**OFF-FARM PARTICIPATION AND FARM HOUSEHOLDS' VULNERABILITY TO
FOOD INSECURITY IN GHANA**

BY

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DECLARATION

This research paper is my original work and has never been presented for a degree award in any other University or institution of higher learning.

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DEDICATION

I dedicate this work of mine to my grandparents Mr and Mrs Colecraft, for their love and care, and also to all farmers across the globe for their production effort in ensuring that humans survive.

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LIST OF ACRONYMS

ADB	African Development Bank
AGRA	Alliance for a Green Revolution in Africa
FAO	Food and Agricultural Organization
FASDEP	Food and Agricultural Sector Development Policy
GDP	Gross domestic product
GHS	Ghana Health Service
GIPC	Ghana Investment Promotion Centre
GLSS	Ghana Living Standard Survey
GSS	Ghana Statistical Service
ICF	International Children’s Fund
INDDEX	International Dietary Data Expansion
LEAP	Livelihood Empowerment Against Poverty
MoFA	Ministry of Food and Agriculture
SADA	Savannah Accelerated Development Authority
SDGs	Sustainable Development Goals
UN	United Nations
USAID	United Nation Agency for International Development

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ABSTRACT

Food insecurity and poverty remain severe and predominant in farming areas in Ghana, and the situation is on the upswing as the population grows at a faster rate (GSS, 2018). In order to improve their wellbeing, farm households are increasingly falling on off-farm activities as an alternative source of livelihood. Yet many government poverty reduction interventions have concentrated mainly on-farm production, ignoring off-farm economic activities. Moreover, empirical studies are presenting conflicting findings on whether off-farm participation practically improves welfare. Thus making it unclear whether off-farm need to be captured in policies and intervention and also whether the policies are to encourage or discourage off-farm participation. Using the Ghana Living Standard Survey (6th round) data for the whole country, and endogenous switching model coupled with Full information likelihood estimator, this study presents a more concrete result correcting for the shortcomings in previous studies such as endogeneity and skewed sample (northern region of Ghana). It further improves on the few studies done before this by including a variable capturing expenditure on non-substitutable market goods such as utility, education, health and housing. The study found that expenditure on health, education and utility significantly increase the chances of farm households engaging in off-farm work. In terms of the effect of working outside the farm on the susceptibility to being food insecure, the study revealed that whether off-farm participation would reduce or increase vulnerability to food insecurity of the farm household, depends on whether the farm household has a comparative advantage on the farm only or both farm and off-farm. This study, therefore, concludes that off-farm economic activities are worth being considered in poverty reduction policies. However, the direction in which the policies are to take must be dependent on the comparative advantage of the farm household in terms of working only on the farm or both given their skills, education and opportunities available.

Keywords: *Off-Farm Participation, Vulnerability, Food insecurity, Welfare, Farm Households, Endogeneity*

CHAPTER ONE

INTRODUCTION OF THE STUDY

1.1. Background

Most of the world's poorest, undernourished and severely food insecure population reside in the remote areas and are involved in diverse forms of agricultural activities with the majority in Africa and South America (World Bank, 2018 and Food and Agriculture Organization (FAO), 2018). About two-thirds of those found in developing countries are members of about 475 million households which are smallholder farmers, operating on farm sizes less than two hectares, and having limited or no access to market and services. (Alliance for a Green Revolution in Africa (AGRA), 2017; Food and Agricultural Organization (FAO), 2015; Ministry of Food and Agriculture (MoFA), 2009). Most of them are from sub-Saharan Africa, with about 9 in every 10 extremely poor people living in countries below the Sahara desert (World Bank, 2018).

In their efforts, farm households over the years have sought to take part in off-farm livelihood activities to diversify their earning streams and to improve on their welfare (AGRA, 2017, FAO, 2015; Ellis and Mdoe, 2003; Barret et al., 2001). Most often in the temporary low skilled and low return non-farm sector during the dry season, with the majority of them being women (Dary and Kunnibe, 2012, Bila et al., 2015). For example, in Nepal, out of 2.7 million small farm holder households, 2.25 million report off-farm activities (FAO, 2015). The increasing education level of farm households, increasing access to telecommunication facilities, roads, banks and long term economic growth have created projections of higher earnings in the off-farm sector thus enhancing the shift in labour supply from farm to off-farm (Huffman, 1980).

The Ghanaian economy, like other developing economies, is also dominated in terms of employment (about 50%) by the agricultural sector (Ghana Investment Promotion Centre (GIPC), 2018). Over half of the households in Ghana own or operate a farm and with the majority representing 82.5% being rural households (Ghana Statistical Service (GSS), 2016). Besides farming, most of them also participate in off-farm economic activities, between one and three members of farm households in Ghana work off-farm (Issahaku & Abdul-Rahaman, 2018), as it is in many low-income economies.

Likewise, in terms of undernourishment, food insecurity and poverty, Ghanaian farm households are the most vulnerable in the country. The low return from rainfall-dependent agriculture, their dependence on marginal lands with low fertility, inadequate access to improved inputs, inadequate storage facilities and high post-harvest losses put farmers at greater threat of being poor and food insecure (Acheampong et al. 2014; Babier & Hochard, 2017). In the seventh and most current living standard survey, it was reported that households headed by farmers are the poorest and also contributes most to Ghana's poverty incidence. The situation was reported to be worse for those with self-employed agricultural household heads (GSS, 2018). The total number of poor people in Ghana was also reported to have increased by close to 400,000 persons based on 2010 projection due to the high population growth rate (GSS, 2018). This thus shows an increased level of food insecurity among the population and potentially adverse effect on the economy in the future.

The most notable ecological zone saddled with food insecurity was the northern savannah. This zone covers Northern, Upper East, Upper West and some parts of the Brong Ahafo region, which are predominantly farming regions (World Food Programme, 2019). A pocket of them was also found in the other regions. According to MoFA, in 2015, the food insecure made up of about 5% of the Ghanaian population with an additional 2 million who are vulnerable to food insecurity

(Darfour & Rosentrater, 2016). The vulnerable population were noted to be concentrated in Brong-Ahafo, Ashanti, Eastern, Volta region and the three Northern regions (Darfour & Rosentrater, 2016). Food insecurity thus appears to be increasing, particularly in farming regions as the population grows faster coupled with acutely limited resources and limited alternative livelihood opportunities (Darfour & Rosentrater, 2016; Kroll et al. 2019; GSS, 2017).

However, this reallocation of labour supply is nevertheless, not very different from what traditional growth models like the Rostow's growth stage model and the dual-sector surplus labour model by Lewis's predict, a movement from an agriculture dominated economy to an industrial economy as a country develops (Todaro & Smith, 2012). This movement per the models is expected to bring improvement in the welfare of all citizens, but specifically to the farm households, this has failed to materialise as they remain undernourished, severely food insecure and needy. Thus, the trickle-down effect has failed in this regard, and the farm households are being deserted in the growing process.

The situation also comes as a big blow to the country, especially after the many poverty reductions and agricultural-led growth policies and interventions implemented by the government (Dzanku and Sarpong, 2014). Ranging from Livelihood Empowerment Against Poverty (LEAP) to Savannah Accelerated Development Authority (SADA), to Food and Agricultural Sector Development Policy (FASDEP) and to the current one dubbed "Planting for Food and Jobs" by the government and corporate bodies. This poses the need for modification of policies, implementation and target groups to capture directly the farmers and their needs. One of the significant shortcomings of these policies is lack of consideration of off-farm or non-farm economic opportunities (World Bank, 2018), a sector which has increasingly become an alternative source of livelihood for farm household (AGRA, 2017; FAO, 2015).

Most of these policies have instead focused on agricultural-led or farm-led growth strategies (Dzanku & Sarpong, 2014) and direct cash transfer strategies. The cash transfer interventions do not have clearly defined channels through which the cash transfers are expected to influence farm production or off-farm production (Quartey, 2018). For example, SADA and “Planting for Food and Jobs”, aimed at modernising agriculture in Ghana in terms of production and marketing, in order to improve small scale farm production (MoFA, 2017; World Bank, 2018). LEAP, which was a direct cash transfer, aimed at improving consumption and income of the poor (Quartey, 2018; Dittoh, 2016; Ayala, 2010). As a result, these policies have yielded impacts below expectation, especially when beneficiaries are compared to non-beneficiaries (Dittoh, 2016). More may thus be achieved in terms of improving farmers’ welfare if off-farm opportunities are considered in these policies since they provide an alternative source of income and market for their produce.

However, the welfare implication of off-farm participation is debatable as many studies which could support the inclusion of it in interventions present conflicting findings. While studies such as Kuwornu et al. (2018), Issahaku and Abdul-Rahaman (2018), Chang and Boisvert (2006), Ellis and Mdoe (2003) and Barret et al. (2001), show that off-farm participation improves welfare and agriculture productivity, others such as Youraj and Anderson (2016), Dzanku (2015), FAO (2015), Dzanku and Sarpong (2014), Awetori (2006), Holden et. al. (2004) and World Bank (2008) show the contrary. These studies show that off-farm participation does not practically improve farmers’ welfare due to many constraints such as skill, capital and marginalisation, making it difficult to earn significant returns from off-farm activities. To some extent, in terms of food insecurity farm households who participate only on the farm are less food insecure relative to those who participate in economic activities off the farm (Dzanku & Sarpong, 2014). These confictions make it

challenging to know whether policies are to be designed to encourage or discourage off-farm participation.

Few of these studies have also looked at the effect of off-farm participation on food insecurity in all farming areas where the food insecure people are, as indicated by MoFA in 2015 (Darfour & Rosentrater, 2016). Instead, most have only concentrated on northern Ghana. Majority of these studies also used Propensity Score Matching technique and linear probability models which ignores unobserved covariates, thus making their results biased in the presence of these covariates. Thus by accounting for these shortcomings, we can present a more confident or concrete result. This result will make clear whether off-farm economic activities should be considered and the direction in which policies and interventions should take.

The welfare of farm households is of much concern to low-income economies like Ghana, which has a large proportion of its households owning or operating a farm, especially in rural areas. Policies influencing off-farm participation would help in improving the welfare of farm household and farm production. Moreover, given that welfare is positively linked with productivity (Haddad & Bouis, 1991), improving on the conditions of farmers will help to ensure inclusive growth in the economy, lower staple food prices, increase demand for rural labour and rural wages (FAO, 2015). Thus, it presents the need for a more precise clarification of off-farm participation and its practical implication on welfare.

In that regard, this study, purposes at examining the effects of participating in off-farm economic activities on farm households' vulnerability to food insecurity as a contribution to the ongoing debate using data from Ghana. It also aims at providing a more concrete justification and direction to consider off-farm participation in interventions aimed at improving the welfare of farmers.

This study will measure vulnerability to food insecurity using food-insecurity indicator; vulnerability to food insecurity or deprivation which measure the percentage of food expenditure in total expenditure (International Dietary Data Expansion (INDDEX), 2018; FAO, 2016; Smith, 2012; Smith & Subandoro 2007). With this, farm households become more vulnerable as the share of their food expenditure share increases based on Engel's law.

1.2. Problem Statement

Farm households in Ghana are living in poor conditions of undernourishment, severe food insecurity and contribute to most of Ghana's poverty incidence (GSS, 2018) despite many policy interventions reported in government documents (Dzanku & Sarpong, 2014). Though increasingly off-farm economic activities have become an alternative source of livelihood for farm households, most of the government interventions implemented have ignored off-farm economic activities (World Bank, 2018). Moreover, the implication of off-farm participation on farm households' wellbeing has also become debatable as studies report conflicting findings (Kuwornu et al., 2018; Tsiboe et al., 2016; Issahaku & Abdul-Rahaman, 2018; Dzanku, 2015; Dzanku & Sarpong, 2014), thus making it unclear whether off-farm economic activities need to be considered in these interventions. It further makes it unclear the mode in which interventions are to be designed to influence off-farm participation, which is whether to encourage or discourage it if it is considered. Majority of these studies have also employed models which present biased estimates in the presence of unobserved covariates and have focused only on northern Ghana ignoring other areas where farming activities take place and the food insecure are also found.

Against this backdrop, this study purposes to look at the implications of participating in economic activities outside the farm as a farm household on how vulnerable in terms of food insecurity the household could be in the whole of Ghana as a further clarification of the debate. It uses data for

Ghana as a whole and accounts for unobserved covariates using endogenous switching model. Unlike previous studies, this study further introduces a variable known as expenditure on non-substitutable market goods. This was included by relaxing the assumption of perfect substitutability between market and home or farm-produced goods in the time allocation model. This variable helps to capture the impact of expenditures on utilities, health, accommodation, education, among others, on the choice to engage in off-farm economic activities or not.

1.3. Objectives

1.3.1. General Objective

The general objective of this study is to examine the effects of off-farm participation on farm households' vulnerability to food insecurity.

1.3.2. Specific Objectives

The specific objectives are:

- i. To determine the relationship between expenditure on non-substitutable market goods and farm households' off-farm participation decision
- ii. To estimate the effects of participating in off-farm on farm households vulnerability to food insecurity.
- iii. To suggest policies which would ensure proper reallocation of farm labour to irradicate food insecurity among farm households in Ghana.

1.4. Research Hypothesis

The null hypothesis of this study are:

H₀: Expenditure on non-substitutable market goods do not have a significant influence on farm households' off-farm participation decision.

H₀: Off-farm participation does not significantly improve farm households' vulnerability to food insecurity.

1.5. Justification of the Study

Findings from this work will be useful to policymakers in redirecting poverty reduction and agricultural-led growth policies and intervention to target effectively the farm households, who are currently the poorest in Ghana (GSS, 2018). Thus, helping to eradicate malnutrition and poverty among rural households, a step towards achieving the first Sustainable Development Goals (SDGs). Specifically, findings from this study would be helpful in the recent intervention dubbed "Planting for Food and Jobs" Launched by the current political regime to boost the agricultural sector contribution to GDP.

It is also recommended that African countries concentrate on making policies that will improve the business of small farm holders and Small and Medium Scale Enterprises due to their dominance in their economies, in order to ensure inclusive economic transformation (AGRA, 2017 & ADB, 2018). The finding of these studies in this regard will be beneficial in offering a guide to how policies are to be designed to influence off-farm participation in order to improve smallholder farmers' welfare and production. By capturing expenditure on non-substitutable goods, this study will offer insight as to how government through subsidies or proper pricing system can adjust the cost of these goods to suit the farm households

This study provides further empirical clarification to the debate about whether farm household participation in off-farm activities improves their welfare with broader data than previous studies conducted. Moreover, this work as well as aids as a reference for advanced studies on the subject matter.

1.6. Organisation of the Study

The study comprises five chapters. The first chapter gives the introduction and the background of the study, the research problem, the objective and the significance of the study. The second chapter critically reviews relevant empirical studies and theoretical works in off-farm participation and farm households' food security. The third chapter expounds on the data source, theoretical and empirical frameworks employed in analysing the data. The fourth chapter captures the empirical analysis, reporting, and interpretation of results. The fifth and last chapter, provides the summary, the conclusion and the recommendation based on the outcome of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents a detailed review of relevant literature to the study from both empirical studies and theories.

2.2. Theoretical Literature Review

This section reviews relevant theories and models which explains farm household behaviour.

2.2.1. Agricultural Household Models

The most basic model which has widely been used in the literature concerning farm household behaviour is the Agricultural Household Model, credited to Inderjit Singh, Lyn Squire and John Strauss in their work on agricultural household models. It explains the behaviour of agricultural household and its consequent effect on economic outcomes in a household-firm framework, whereby the household produces and consumes farm goods and the surplus sold (Singh et al., 1986). The prime aim of the agricultural household in the model is to maximise total wellbeing¹. It does that by choosing an optimal consumption of staple or domestically-made goods, market goods and leisure constrained by the farm production technology, total income and total time endowment (Singh et al., 1986).

It assumes that farm households are partly-commercial, they buy some inputs and sell some of their output (Singh et al., 1986), a case typical in many sub-Saharan countries, including Ghana. It also assumes that agricultural household decisions are recursive contrary to the traditional theory of household behaviour, and it occurs only through what the model terms as profit effect. A

¹ Total wellbeing is measured by the mean income of the household (Singh et. al., 1986).

situation whereby production decision affects profit which also affects agricultural household income and in turn influences household consumption and labour supply. Thus making farm households' decision to produce and consume inseparable in terms of income but in terms prices separable. It further assumes one crop production and a single-family head who makes decisions for the household, a scenario predominant in most developing countries (Singh et al., 1986).

It has however, undergone many series of modification and extensions which have led to the inclusion of some variables in explaining farm household behavior such as borrowing behaviors, seasonal variations, uncertainties, macro-level policies, the human capital in the household, multiple crops, double-period model, household production technology and many others (Singh et al., 1986; Findeis et al., 2003). In the 90s, in order to better understand farm household welfare outcomes, attention was shifted to the joint household utility to incorporate a wide range of outcome variables including nutrition, an aspect of which is considered in this study, consumption, fertility of the labour supply, inter-generational transfers among others (Singh et al., 1986; Findeis et al., 2003). This shift of attention gave rise to the collective model and the bargaining model, whereby in the collective model household utilities are maximised jointly, and in the bargaining model each household member maximises its utility (Findeis et al., 2003).

Though these modifications are laudable generally, their application relies on the setting and farm households' features. Given this study, making use of data from farm households in a developing country, Ghana, we stick to the collective preference because in such areas decision in the household is made jointly mostly by the head (FAO, 2015). Also, the one-period dataset being used in this study does not permits these modifications to be accounted for. For instance, the data were collected in one single period, which makes it impossible to apply the double period model. Davies (1996) and Ellis (2000) extended the model to cover all rural households and categorized

further the reasons which lead to income diversification into the non-farm sector into two; necessity and choice motivated reasons (Ellis, 2000). The choice motivated reasons were intentional and pre-emptive such as searching for seasonal wage earning prospects, mobilizing funds to invest in off-farm enterprises such as trading among others, while the necessity motivated reasons were circumstantial such as the prevention of occupant families from accessing farmlands, environmental degradation, natural or civil disasters, to mention but a few. (Ellis, 2000). This extension though merely descriptive provides information about the potential determinants regarding the decision to participate in off-farm or not. Nevertheless, whichever category the reason for diversification may be, the ultimate goal is to improve household welfare and thus require an optimum diversification expected of a rationale household.

However, the primary source of criticism of this model is the assumption of a competitive rural labour market. This assumption gives rise to separability in agricultural household decision making based on prices and also implies that family labour can perfectly substitute labour hired (Skoufias, 1994). Critiques such as Lopez (1984), Jacoby (1993), Strauss (1994) and Skoufias (1994) argue that labour from family and hired ones, as well as the labour between family members, are not perfect substitutes such that recursive property can also occur through the income effect using the shadow wage. That is directly through changes in shadow profits and indirectly through variation in family's shadow wage. Thus exogenous factors affecting the family's shadow wage will affect the labour supply decision of the household, the decision to produce and to consume (Skoufias, 1994).

These critiques argued that it is not appropriate to use market wage which reflects the preferences of a minor set of wage-earning labourers as against a bigger set of self-employed farm labour force to value family labour (Jacoby, 1993; Skoufias, 1994). They further argued that variations in

family's shadow wage instead determine the labour supply decision of agricultural households in terms of working on and off-farm work, together with leisure (Skoufias, 1994).

The result of their criticism gave rise to the modified model known as the "Time Allocation Model" first proposed by Becker, 1965. The time allocation model maintains the recursive property but relaxes the stringent assumption of perfect substitute between family and hired labour (Jacoby, 1993). Here, off-farm participation is a choice made by farm households by comparing the marginal values of farm-work or leisure (shadow or reservation wage) to non-farm wage opportunities. The number of children and demographic characteristics of the adults are exogenous to the model (Abdulai & Delgado, 1999). In this model also, the farm household's objective is the same as the basic farm household model. The central proposition concerning labour supply and welfare is that an optimal time and resource allocation to working on the farm and off-farm, as well as leisure based on shadow wage, should improve household welfare.

Due to the focus of this study (off-farm participation and food insecurity), we adopted the Time Allocation Model. Here, farm households also undertake a similar decision as presented in the basic farm household model but include working outside the farm. However, one weakness of time allocation model this study attempts to solve is maintaining the assumption of perfect competitive rural output market, which implies farm or home produce and market goods are perfect substitutes (Abdulai & Delgado, 1999). This study relaxes this assumption, under the rationale that, while goods that are food-related and basic household services like cooking, cleaning among others are substitutable, goods and services such as utilities, education, health care among others are likely not substitutable. It is, therefore, possible that the share of these non-substitutable goods and services in household expenditure can influence a household's labour supply decision and as such avoiding to control for these may result in misleading results.

2.3. Empirical literature review

The trend of farm households allocating all their time to farm work has changed, with most farm households in developing and developed economies partaking in other economic activities off-farm alongside their main farm work. However, the implication of off-farm work participation on their food security and welfare, in general, is debatable as many empirical studies instead report conflicting findings.

Tsiboe et al. (2016) used linear regression model with endogenous treatment effect to analyse the relationship between diverse non-farm economic activities and the availability of nutrients in household's consumption life in the northern part of Ghana. They revealed among others that farm households who participate in off-farm activities by working for others, in search of supplementary income appear to be more food insecure compared to those who engage in only farming. Kuwornu et al. (2016) conducted a similar study in the forest areas of Ghana's central region using binomial logit model. Their study also revealed that low own-farm production contributes to 60% of farm households in the area being food insecure and nutritionally deficient in status. Also, similar to the above studies but using cross-country data both in Africa and South Asia, Carletto et al. (2015) found a direct and significant connection between agricultural production and output level of farm households, dietary patterns, and food security. These studies thus show a strong positive linkage between more on-farm work and food security of farm households relative to participating more in off-farm work.

On the contrary, Kuwornu et al. (2018), used propensity score matching (PSM) technique to assess the outcome of off-farm participation on farm households' food security state using data from the northern region of Ghana. Their study found out that off-farm participation increases household daily calorie consumption, thereby improving food security. In the same setting, using the same

propensity score matching (PSM) technique, Owusu et al. (2011) also revealed that off-farm participation have a significant positive influence on food security status among farm households. The same result was obtained in northern Ghana but using Feasible Generalized Least Squares method by Zereyesus et al. (2016). In a similar study in Nigeria but using instrumental variable approach, Babatunde and Qaim (2010) revealed that off-farm income improves food security and nutrition. These studies, on the contrary, indicate a strong positive linkage between off-farm participation and farm households food security as compared to on-farm work only.

The debate as well continues with other welfare indicators such as income and inequality. Egyei and Adzorkor (2013) used Heckman two steps procedure to investigate the influence of off-farm earnings on Ghanaian rural agricultural productivity. They revealed a significant negative relationship between farm earnings per capita and off-farm earnings. Dzanku (2015) focused on household welfare measure in a multidimensional perspective in a similar study using pooled probit. The study concluded that it might not be profitable counting on the off-farm sector as compared to the on-farm sector in reducing rural poverty in Ghana. Their result supports the findings obtained in a simulation study in the Ethiopian highlands which revealed among others that ideally unrestricted chances to earn low-wage income from off-farm should increase the revenues of rural farm households but access to such incomes are constrained (Holden et al., 2004). Thus making it difficult for the farm households to realize any significant gains and impact on their welfare (Holden et al., 2004), and to some extent participating in off-farm work contributes to widening instead of bridging income inequality among rural households (Mata et al., 2012, Senadza, 2011; Rahut & Scharf, 2012). These studies again show a negative linkage between the revenues and welfare of rural households and off-farm participation.

On the contrary, Issahaku and Abdul-Rahaman, 2018 used an extended regression model (endogenous switching model) to examine the influence of participating in off-farm economic activities on how vulnerable a household is to poverty in Ghana, specifically some parts of the savannah regions. They reported a 13% significant reduction in households' vulnerability to poverty by participating in non-farm economic activities. Shehua and Sidiquea (2014) in examining the consequences of participating in enterprises outside the farm on households' welfare, using PSM approach, also concluded that participating in off-farm significantly improves household welfare by all standards in Nigeria. In support of their finding and also in Nigeria, Billa et al. (2015) used logit regression model in a similar study and based on their findings they established that off-farm work advances the living standard of Hawul and Borno farm households. In terms of inequality, Chang and Boisvert (2006), Ellis and Mdoe (2003), Barret et al. (2001) and others revealed that non-farm income closes the gap between households who farm and those who do not. These set of studies, on the contrary show a strong positive association between participating in economic activities outside the farm as a farmer and welfare.

However, these studies which consider overall welfare usually using poverty status lacks the other specific measures of household wellbeing such as food insecurity and nutritional status, gender - based inequality, health, and others. In policy application, it becomes confusing as to which aspect of farm household lives contribute to their poor welfare and so to be targeted. Thus it is imperative to break household welfare into the various components of household livelihood, which include food security which this study is considering.

Though the ultimate aim of participating in off-farm economic activities is to supplement farm earnings and improve welfare, studies have revealed many other socioeconomic and demographic factors influencing off-farm participation decision and its welfare implications. Using a bivariate

probit model, McCarthy and Sun (2009) and Abdulai and Delgado (1999), investigated the factors that influence sex-based off-farm participation decision in rural northern Ghana. They identified education and other variables as a positive determinant of participating in off-farm by both sexes, with the relationship being stronger with women participation than men. Similarly, in Mexico using the same model, education was found to be a positive determinant of off-farm participation by Janvry and Sadoulet (2001) and in the USA by Huffman (1980). However, in Ethiopia, using the same model household heads' education level was found to have insignificant because majority of the activities available off-farm did not demand formal education (Beyene, 2008). This suggests that determinants are sensitive to the characteristics of the study area.

Aside education, the following determinants among others have also been identified as positively significant using bivariate probit model, availability of off-farm opportunities (Janvry & Sadoulet, 2001), adoption intensity of bunds and organic manure (Issahaku & Abdul-Rahaman, 2018), availability of telecommunication infrastructure, availability of roads, banks (Egyei & Andover, 2013), availability of credit and transfer income (Beyene, 2008), know-how, infrastructure, nearness to the capital, population concentration, and among others, with significant differences by gender (Abdulai & Delgado 1999).

Though bivariate probit model is very efficient than pooled probit and logit model because it controls for potential unobserved cofounders through joint estimation and by assuming the error terms are correlated but should they be wrongly assumed to be correlated, the result from joint estimation of the equations will be inefficient thus the need for correlation estimator test (Fleming & Kler, 2008). Moreover, this model requires including identifying restrictions which are challenging to obtain (Fleming & Kler, 2008) and also given that the studies were conducted in a

different setting, the restrictions are also likely to vary with the setting and by extension influence the significance of the determinants considered, thus suggesting setting specific determinants.

Moreover, the conflicting results of these studies concerning the effects of participating in off-farm economic activities on food security and welfare in general can, to some extent be explained in the context of the empirical model used. For example results obtained from studies using Propensity Score Matching (Kuwornu et al., 2018; Owusu et al., 2011; Shehua & Sidiquea , 2014), may be affected by unobserved confounders because the model only deals with observed confounders or endogenous covariates other than the treatment variable (Maddala & Nelson, 1975). Also, studies which used linear probability models (Kuwornu, et al., 2016; Billa et al., 2015; Dzanku, 2015) failed to account for sample selection bias and endogeneity, which can affect their results and make them inefficient. On the other hand, endogenous switching model used in Issahaku and Abdul-Rahaman (2018) and Heckman selection model used in Egyei and Adzorkor (2013) correct for sample selection bias thus making the result obtained from these studies more efficient. However, these models can also be inefficient if the assumption of a joint normal distribution of the stochastic error terms fails (De Luca, 2008). Thus the need to ensure this assumption is met.

2.3.1. Overview of Literature

First, from the above review, it is evident that there are conflicting results. Most of the studies also employed empirical model which suffers from sample selection bias either from both the observed and unobserved confounders (Kuwornu et al., 2016; Billa et al., 2015; Dzanku, 2015) or only unobserved confounders (Tsiboe et al., 2016; Kuwornu et al., 2018; Zereyesus, et al., 2016; Shehua & Sidiquea, 2014) thus reducing the efficiency of their estimates. Heckman Selection Model and

Endogenous Switching Model, on the contrary, are models suitable for this study given its objectives.

This study, however, adopted the Endogenous Switching Model because it controls for potential endogeneity and also enables the researcher to estimate the average treatment effect (Issahaku & Abdul-Rahaman, 2018). This study differs from Issahaku and Abdul-Rahaman (2018) by looking at vulnerability to food insecurity measure instead of general poverty as used in their study. Heckman Selection Model though also efficient and can be modified to account for its major limitation of potential non-normality and heteroscedasticity of the residuals (Heckman, 1974; Dutoit, 2007) but the process involved is cumbersome (Issahaku & Abdul-Rahaman, 2018). Also, since food insecurity status which is the outcome variable is observed for both regimes, it may not be appropriate to use Heckman Selection Model because there is no issue of selection bias resulting from unobserved outcomes of any regime (Heckman, 1974; Dutoit, 2007).

Secondly, there is an issue of setting specific characteristics when finding the determinants off-farm participation, as shown by the conflicting result for education. Though few studies have been done in Ghana, most have concentrated on the northern regions or parts of Ghana, ignoring the fact that agricultural activities also take place in other parts of the country and as well few have tried to look at food security and off-farm participation in the whole country. This, among other gaps revealed above, underpins the need for this study, extending the argument to other areas in Ghana where farming activities take place since food insecurity and poverty are noted to be high among farm households. The study takes into consideration country-specific effects as well.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter covers a comprehensive explanation of the theoretical and empirical framework employed in this study.

3.2. Theoretical Framework

The primary model this paper adopts is the time allocation model presented in Abdulai & Delgado (1999) with some modification. In this model, the household is modelled as an economic agent who seeks to maximise its welfare by choosing an optimal consumption good to purchase, optimal allocation of time to off-farm and on-farm work, as well as an optimal amount of leisure. The underlying assumptions of the model are, a household consist of the husband and wife, but in this study, the utilities of both members of the household are combined not separated. As a result, the overall welfare decision of the household is assumed to be made by a single head, as the case is in most of the farming areas in Ghana. Households' entire time resources are distributed to either off-farm, on-farm work or leisure. Based on the assumptions of the model stated in the theoretical review, a typical household utility function takes the general functional form as follows:

$$U_i = U(Q, L; \delta) \dots \dots \dots (3.1)$$

Where Q is the total amount of goods consumed, L is total hours of household leisure, and δ represent a vector of parameters for household characteristics such as demography (Abdulai & Delgado, 1999). However, by relaxing the assumption of perfect substitute between home-produced goods and market goods, the above utility function is modified to take the form:

$$U_i = U(Q_S, Q_N, L; \delta) \dots \dots \dots (3.2)$$

Where Q , the total amount of goods and services consumed is decomposed into substitutable Q_s and non-substitutable market goods and services Q_n . The household faces a time constraint expressed as:

$$T = T_1 + T_2 + L \dots \dots \dots (3.3)$$

Where T the total time endowment of a household, T_1 denotes hours assigned to farm work, T_2 denotes hours assigned to non-farm work and L denotes hours assigned to leisure. Since the optimal time assigned to off-farm activities T_2 can be zero but not less than zero, we imposed a strictly positive constraint on hours of participating in off or non -farm work (Abdulai & Delgado, 1999), as follows:

$$T_2 \geq 0 \dots \dots \dots (3.4)$$

A concave and double differentiable production function is adopted for the farm production technology in order to ensure that the second-order condition is met (Abdulai & Delgado, 1999):

$$Y = Y(T_1, H, X; S, V, K) \dots \dots \dots (3.5)$$

Where T_1 represent time allocated to farm production, H represent labour hired, and X represents bought inputs aside labour. S represents a vector of household features production, V is a vector of invariant factors; for example, a plot of land and K represent a set of locational characteristics. The household's budget constraints on the quantity of goods consumed or employed as input on the farm, which is obtained from the market and other non-market production are as follows:

$$P_s Q_s + P_n Q_n = W_2 T_2 + P_y Y - P_x X - W_h H + R = I \dots \dots \dots (3.6)$$

Where P_s, P_n, P_x and P_y denote prices of substitutable commodities and services, non-substitutable market goods and services, farm output, and non-labour input, respectively. W_2 and

W_h are the households' off-farm work wages and labour hired, respectively. Y, I and R are farm output, total household income and non-labour income such as remittances, off-farm properties respectively. The household's maximisation problem is, therefore, represented as follows:

$$L = U(Q_s, Q_n, L; \delta) + \mu(T - T_1 - T_2 - L) - \gamma[P_s Q_s + P_n Q_n - W_2 T_2 - P_y Y(T_1, H, X; S, V, K) + P_x X + W_h H - R] \dots\dots\dots (3.7)$$

Where μ and γ are the Lagrangian multipliers associated with a change in household total time endowment and income, respectively. Maximising Q_s, Q_n, T_1, T_2, L and X and solving for the households optimal time allocation to on-farm work, non/off-farm work and leisure yield the following structural demand function:

$$T_1^* = T_1(W_1, W_2, P_y, P_x, S, V, K) \dots\dots\dots (3.8)$$

$$L^* = L(W_1, W_2, P_y, P_x, P_s, P_n, \delta, S, R, K) \dots\dots\dots (3.9)$$

$$T_2^* = T - T_1^* - L^* = T_2(W_1, W_2, P_y, P_x, P_s, P_n, \delta, S, R, K) \dots\dots\dots (3.10)$$

The household head's off-farm participation decision depends on the reservation wage compared to the off-farm market wage. We use equation (3.10) to work for reservation wage for off-farm participation, assuming household allocates all it is time to on-farm activities and leisure. Off-farm reservation thus equals the household's marginal worth of total time endowment when it allocates all to working on-farm and leisure. Thus factors that affect them will as well affect off-farm reservation wage, and in turn influence, off-farm participation expressed as follows

$$W^r = W^r(W_2, P_y, P_x, P_s, P_n, \delta, S, R, K) \dots\dots\dots (3.11)$$

Where Z_i^* is dichotomous, with a value 1 if the household engages in off-farm activities and 0 if the household does not. α is an (individual household-specific) intercept, X_i is a vector of independent variables affecting the participation decision as stated in equation (3.11), β is a vector of parameters to be estimated, and u_i is a stochastic error term. This first part of the model estimates the off-farm participation equation using FIML estimator. The dichotomous term can be presented as follows:

$$Z_i^* = \begin{cases} 1 & \text{if } W^m > W^r \\ 0 & \text{if } W^m \leq W^r \end{cases} \dots\dots\dots (3.13)$$

The second stage, which is the impact equation shown below, was estimated using a linear regression model because the outcome variable (vulnerability to food insecurity) is continuous.

$$C_i^* = \begin{cases} \alpha_1 + \beta_1 Y_{1i} + \varepsilon_{1i} & \text{if } W^m > W^r \\ \alpha_2 + \beta_2 Y_{2i} + \varepsilon_{2i} & \text{if } W^m \leq W^r \end{cases} \dots\dots\dots (3.14)$$

Where C_i^* is the continuous, observed outcome variable representing the food insecurity effect of participating in off-farm activities. Vulnerability to food insecurity was measured using household food-insecurity indicator; the proportion of total spending on food, based on Engel’s law⁴ (INDDEX, 2018; FAO, 2016; Smith, 2012; Smith & Subandoro, 2007). (Y_{1i}, Y_{2i}) are the vectors of covariates which influence vulnerability to food insecurity under the two regimes, (α_1, α_2) are intercepts, (β_1, β_2) are vectors of coefficients, and $(\varepsilon_{1i}, \varepsilon_{2i})$ are random error terms. Due to the potential correlation of the error terms, we assumed them to be trivially and normally distributed, having a mean of zero and a covariance matrix of the error terms shown below (Lokshin & Sajaia, 2004).

⁴ According to Engel’s law a larger share of food expenditure in total expenditure implies more food insecurity and more vulnerable to food deprivation and vice versa (INDDEX, 2018).

$$cov(u, \varepsilon_1, \varepsilon_2) = \begin{bmatrix} \sigma_u^2 & \sigma_{1u} & \sigma_{2u} \\ \sigma_{1u} & \sigma_1^2 & . \\ \sigma_{2u} & . & \sigma_2^2 \end{bmatrix} \dots\dots\dots (3.15)$$

Where $\sigma_{1u} = cov(u_i, \varepsilon_{1i})$, $\sigma_{2u} = cov(u_i, \varepsilon_{2i})$ and $.$ = $corr(\varepsilon_{1i}, \varepsilon_{2i})$ which is undefined because C_2^* and C_2^* are not observed simultaneously. σ_u^2, σ_1^2 and σ_2^2 are, on the other hand, the variances of the error terms in the participation or selection equation and the continuous outcome equation, respectively. The identification of the model is achieved through nonlinearities in the absence of any exclusion restriction (Lokshin & Sajaia, 2004). Based on the distribution of the error terms as assumed above, the logarithmic likelihood function of equation (3.13) is expressed as

$$lnL = \sum_i (Z_i^* w_i [ln\{F(\eta_{1i})\} + ln\{f(\varepsilon_{1i}/\sigma_1)/\sigma_1\}] + (1 - Z_i^*) w_i [ln\{1 - F(\eta_{1i})\} + ln\{f(\varepsilon_{2i}/\sigma_2)/\sigma_2\}]) \dots\dots\dots (3.16)$$

Where F follows a cumulative normal distribution function (cdf), with density f which is also normally distributed, weight for observation i as w_i and

$$\eta_{1i} = \frac{(BX_i + \rho_j \varepsilon_{ji} / \sigma_j)}{\sqrt{1 - \rho_j^2}} \quad j = 1, 2 \dots\dots\dots (3.17)$$

In equation (17) $\rho_1 = \sigma_{1u}^2 / \sigma_u \sigma_1$ and $\rho_2 = \sigma_{2u}^2 / \sigma_u \sigma_2$ and they estimate the coefficient of correlation between u_i and ε_{1i} and u_i and ε_{2i} , respectively. In order to ensure that the correlation coefficients (ρ_j) are restricted between -1 and 1 and the estimated covariance (σ_j) are always greater than zero. The ML method directly estimate $ln\sigma_j$ and $atanh \rho$ given as:

$$atanh \rho_j = \frac{1}{2} \ln\left(\frac{1 + \rho_j}{1 - \rho_j}\right) \dots\dots\dots (3.18)$$

One major merit of using endogenous switching model is its ability to estimate and compare the expected outcome of the observed and the counterfactual conditionally and unconditionally based

on the regimes. Regarding this study, is its ability to estimate the susceptibility to being food insecure (food expenditure share) in the cases of households who did or did not work off-farm and their counterfactuals. Below are the methods the model uses to estimate the expected outcomes.

Unconditional expectation:

$$E(C_{1i}^* | Y_{1i}) = Y_{1i}\beta_1 \dots\dots\dots (3.19a)$$

$$E(C_{2i}^* | Y_{2i}) = Y_{2i}\beta_1 \dots\dots\dots (3.19b)$$

Conditional expectation in observed cases:

$$E(C_{1i}^* | Z_i^* = 1, Y_{1i}) = Y_{1i}\beta_1 + \sigma_1\rho_1 f(\beta X_i)/F(\beta X_i) \dots\dots\dots (3.20a)$$

$$E(C_{2i}^* | Z_i^* = 0, Y_{2i}) = Y_{2i}\beta_2 - \sigma_2\rho_2 f(\beta X_i)/\{1 - F(\beta X_i)\} \dots\dots\dots (3.20b)$$

Here we obtain the expected food expenditure share of farm household who participate in off-farm in the first equation (3.20a) and that of those who do not participate in off-farm in the second equation (3.20b).

Conditional expectation in unobserved cases:

$$E(C_{1i}^* | Z_i^* = 0, Y_{1i}) = Y_{2i}\beta_1 - \sigma_1\rho_2 f(\beta X_i)/\{1 - F(\beta X_i)\} \dots\dots\dots (3.20c)$$

$$E(C_{2i}^* | Z_i^* = 1, Y_{2i}) = Y_{1i}\beta_2 + \sigma_2\rho_1 f(\beta X_i)/F(\beta X_i) \dots\dots\dots (3.20d)$$

Also, here, we obtain the expected food expenditure share of farm household who participate in off-farm if they did, in the first equation (equation 3.20c), and that of those who do not participate in off-farm if they had, in the second equation (equation 3.20d). With the above set of conditional equation, the study was able to estimate the average treatment effect on the treated (*ATT*) and the untreated (*ATU*) as follows:

$$ATT = E(C_{1i}^* | Z_i^* = 1, Y_{1i}) - E(C_{2i}^* | Z_i^* = 1, Y_{2i}) = Y_{1i}(\beta_1 - \beta_2) + \rho_1(\sigma_1 - \sigma_2) f(\beta X_i) / F(\beta X_i) \dots \dots \dots (3.21a)$$

$$ATU = E(C_{1i}^* | Z_i^* = 0, Y_{1i}) - E(C_{2i}^* | Z_i^* = 0, Y_{2i}) = Y_{2i}(\beta_1 - \beta_2) + \rho_2(\sigma_1 - \sigma_2) f(\beta X_i) / \{1 - F(\beta X_i)\} \dots \dots \dots (3.21b)$$

The *ATT* tells the effect of participating in off-farm on the vulnerability to food insecurity of those who participated (equation 3.21a). To capture farm household unobserved heterogeneity, this study included an estimation on the base heterogeneity of farm household who participate *HT₁* and not participate in off-farm *HT₂*. *HT₁* gives the difference between the expected food expenditure share of household who participated in off-farm (equation 3.20a) and the counterfactual hypothetical case, which is the expected food expenditure share of those who did not participate, if they did (equation 3.20c). *HT₂* gives the difference between the expected food expenditure share of household who participated in off-farm, if they did not (equation 3.20d) and the expected food expenditure share of those who did not participate (equation 3.20b). The base heterogeneity is shown below:

$$HT_1 = E(C_{1i}^* | Z_i^* = 1, Y_{1i}) - E(C_{1i}^* | Z_i^* = 0, Y_{1i}) = \beta_1(Y_{1i} - Y_{2i}) + \sigma_1(\rho_1 - \rho_2)[f(\beta X_i) / F(\beta X_i) + f(\beta X_i) / \{1 - F(\beta X_i)\}] \dots \dots \dots (3.22a)$$

$$HT_2 = E(C_{2i}^* | Z_i^* = 1, Y_{2i}) - E(C_{2i}^* | Z_i^* = 0, Y_{2i}) = \beta_2(Y_{1i} - Y_{2i}) + \sigma_2(\rho_1 - \rho_2)[f(\beta X_i) / F(\beta X_i) + f(\beta X_i) / \{1 - F(\beta X_i)\}] \dots \dots \dots (3.22b)$$

Also, to know the strength of impact participating in economic activities outside the farm has on food insecurity status for those who participated (equation 3.20a) and those who did not participate

if they did, in the counterfactual case (equation 3.20c). This study estimated the transitional heterogeneity (*TRH*) by finding the difference between *ATT* and *ATU*⁵.

3.4. Data Description and Variable Measurement

This study depended on the cross-sectional data available in Ghana Living Standard Survey 6th report (GLSS6), a series of national and regional living standards data collected on various socio-economic indicators and consist of income and expenditure from all facets of household living including agriculture. The survey was conducted by the Statistical Service of Ghana from October 2012 to October 2013 and is the most recent round conducted relating to this study. Unlike the previous rounds, this round (6th survey) contains a module on Non-farm Household Enterprises, which makes it suitable for this study. The survey covered a national representative of 18,000 sample households, in 1,200 enumeration areas. From the 18,000 households, 16,772 were effectively and randomly enumerated signifying 93.2 percent rate of response (GSS, 2014). The survey is based on random sampling techniques, thus making it possible for results obtained from the use of the data to be generalised. Among 16772 households who were enumerated, 7445 (44.4%) were urban households and 9327 (55.6%) rural households, which shows that the data was not skewed towards a section of households. Majority of the heads were also engaged in the agriculture and fishing industry: 8439 (52.36%) and commerce industry 2519 (15.63%). This reinforces the usefulness of the data in this study. This study, however, used the CPI deflator provided in the data set to convert the income and expenditure values into real value terms

⁵ The section on empirical framework follows the work of Lokshin et. al (2004) and Ndwiga (2019)

Table 3.1: Measurement of Variables

Variable	Measure	Expected Sign	Reference
Dependents			
Vulnerability to food insecurity (C)	Percentage of real food expenditure in real total expenditure (GHS)		Smith (2012)
Off-farm participation (Z)	1 if household earn from non-farm enterprise, 0, otherwise	Negative	Issahaku and Abdul-Rahaman (2018).
Independents			
Farm and Off-farm Profitability			
Farm profit (GHS)	Real net income of household from Agriculture	Negative	Kuwornu et al. (2016)
Off-farm profit (GHS)	Real net income of household from non-farm enterprise	Positive	Abdulai and Delgado (1999)
Cost of Substitutable Market Goods			
Expenditure on market foods (GHS)	Real total household expenditure on purchased food	Positive	Kuwornu et al. (2016)
Cost of Non-Substitutable Market Goods			
Expenditure on utility (GHS)	Real total household expenditure on electricity and gas	Positive	New variable introduced by this study
Expenditure on education (GHS)	Real total household expenditure on education	Positive	
Expenditure on Housing (GHS)	Real total household expenditure on housing	Positive	
Expenditure on healthcare (GHS)	Real total household expenditure on health	Positive	
Household characteristics affecting utility(δ) and production (S)			
Household head's education level	Highest level of education completed by the household head (Dummy for each level, 1 if household head completed that particular level, 0 otherwise)	Positive	McCarthy and Sun (200), Huffman (1980) Tsiboe et al. (2016) Kuwornu et al. (2016)

Size of Household	Number of household members	Positive	Zereyesus et al. (2016).
Male-headed household	1 if household head is male, 0 otherwise	Positive	and among others
Household head marital status	Dummy for each category (1 if the household is in particular category, 0 otherwise)		
Size of livestock own	Total number of livestock owned by household	Negative	
Size of agricultural land own	Total size of agricultural land owned by household in hectares	Negative	
Size of poultry own	Total number of poultry birds owned by the household	Negative	
Household head has a bank account	Dummy, 1 if yes 0, otherwise	Positive	
Non-labor income/ Transfers (R)			
Annual remittance received (GHS)	Real total annual income remittance received	Negative	Abdulai and Delgado (1999)
Locational Characteristics(K)			
Region	Region of residence (Dummy for each region)		
Urban area	1 if Urban, 0 if rural	Positive	Dzanku (2015)
Time taken to reach the closest health facility	Measured in hours	Negative	

3.5. Diagnostic Test

The following test was conducted to ensure efficient and reliable results from the study.

3.5.1. Multicollinearity

Given that multicollinearity is an issue in OLS estimation technique, the correlation matrix analysis of independent variables was employed to test for linear correlation between the independent variables in both equations, to prevent inflation of the variances of the parameters

estimated and in turn avoid wrong conclusion (Greene, 2012). Independent variables which were found to have strong correlation were dropped.

3.5.2. Heteroscedasticity

It is ubiquitous that heteroscedasticity is a major issue when using cross-sectional data, making it difficult to make a consistent inference from regression results. To detect the presence of heteroscedasticity, the study estimated two models, one with robust standard errors and one without robust standard errors and compared the values of the standard errors. Robust standard errors were applied to correct the heteroscedasticity when the standard errors were found to be different.

3.5.3. Falsification Test

The study employed the method of exclusion restriction whereby at least a variable is included in the selection equation (off-farm participation) but not in the outcome equation (nutritional status) as an instrument to prevent potential identification problem. The study used a falsification test to identify suitable variables which could be used as an exclusion restriction or instruments. It regressed the independent variables on the outcome variable for household who did not participate in off-farm. Using the same set of independent variables, the study also conducted a probit regression with off-farm participation status as the dependent variable. Variables which were statistically significant in the off-farm participation equation but not in the outcome equation were used as instruments or restrictions (Ndwiga, 2019; Issahaku & Abdul-Rahaman, 2018)

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter presents the results from the descriptive and econometric analysis of the variables used in this study, their interpretations, as well as their economic and statistic implications.

4.1. Descriptive Analysis

This section reports the characteristics of the farm households and their heads. It also describes the variables used in the econometric model. A farm household in this study is a household with a head whose primary occupation is farming (OECD, 2019). Out of the total number (16772) of household surveyed in the GLSS6 survey, 8439 of them, representing 50.3% were farm households based on the above definition. Among these farm households, 2552 representing 30.2%, participated in off-farm works. Table 4.1 reports the summary statistics of the demographic and other characteristics of these farm households based on their off-farm participation status.

The result shows that majority of the farm households are headed by males and as a result, the percentage of both male-headed households who participated and did not participate in off-farm are greater as compared to females. However, taking only the female-headed household, a greater percentage of them did not participate in off-farm economic activities. This result reflects the typical African setting, especially rural areas where most heads of families are male and in terms of economic opportunities, men stand a better chance than the women.

Table 4.1 Summary Statistics of Variables

Variable	Off-farm Participant				Non-Off-farm Participant			
	Mean	Std. Deviation	Minimum	Maximum	Mean	Std. Deviation	Minimum	Maximum
Vulnerability to food insecurity (%)	54.69	15.46	1.45	98.96	60.04	15.71	1.82	98.67
Farm profit (GHS)	572476.76	2608304.77	-25557786.00	82110880.00	568763.05	3232913.38	-52097280.00	192514752.00
Off-farm profit	-28.61	238.35	-10246.40	2519.31				
Annual remittance received (GHS)	47783.68	176749.45	0	4886376.50	48510.72	243924.56	0	12219606.00
Expenditure on utility (GHS)	22086.23	71202.43	0	1349861.50	12181.46	87251.57	0	5350582.00
Expenditure on housing (GHS)	133637.41	548442.08	0	17863912.00	73666.31	300411.32	0	12578266.00
Expenditure on healthcare (GHS)	22106.81	59664.40	0	1334420.50	15632.76	39659.08	0	978443.13
Expenditure on education (GHS)	153885.22	316906.56	0	6390647.50	86778.24	207070.04	0	4669177.00
Expenditure on market foods (GHS)	611060.53	458372.70	1783.53	5398024.00	476173.77	404219.45	0	7021747.50
Size of household	5.93	3.01	1	29	4.60	2.95	1	25
Size of poultry own	17.41	131.49	0	5600	11.38	24.78	0	1000
Size of agricultural land own	0.68	2.44	0	40.47	0.58	6.27	0	293.40
Size of livestock own	7.56	16.00	0	360	6.21	42.16	0	3126
Time taken to reach the closest health facility	0.18	0.72	0	14	0.20	1.01	0	40
Male-headed household	0.16	0.36	0	1	0.24	0.43	0	1

Household with never married-head	0.01	0.12	0	1	0.05	0.21	0	1
Household with married-head	0.85	0.36	0	1	0.71	0.45	0	1
Household with divorced - head	0.14	0.35	0	1	0.24	0.43	0	1
Household head has no education	0.35	0.48	0	1	0.46	0.50	0	1
Household head has not completed Pre-school/ primary	0.13	0.34	0	1	0.12	0.33	0	1
Household head has completed primary	0.11	0.31	0	1	0.12	0.32	0	1
Household head has completed lower secondary	0.28	0.45	0	1	0.19	0.40	0	1
Household head has completed upper secondary	0.04	0.19	0	1	0.03	0.17	0	1
Household head has completed post-secondary technical	0.02	0.13	0	1	0.01	0.12	0	1
Household head has completed university and higher	0.01	0.08	0	1	0.01	0.08	0	1
Household head has completed formal adult education/literacy program	0.07	0.25	0	1	0.05	0.22	0	1
Rural area	0.78	0.41	0	1	0.84	0.37	0	1
Urban area	0.22	0.41	0	1	0.16	0.37	0	1
Household head has bank account	0.33	0.47	0	1	0.20	0.40	0	1

Also, the results show a greater proportion of the farm households are found in the rural areas, and as a result, the percentage of rural household who participated and did not participate in off-farm is greater as compared to urban. This reflects the fact that in Ghana and many other African countries, agriculture or farming is predominantly a rural activity. Though the higher percentage of the farm household who did not participate in off-farm activities (84%) are rural type, taking only the urban farm households, majority of them participated, about 24% as compared to 16% who did not participate in off-farm economic activities. This also reflects the lack of off-farm opportunities in rural areas.

The outcomes presented by table 4.1 also indicate that majority of the households have heads who are married, about at least 71% of them in both off-farm participation statuses, and among them, a higher percentage, 84%, participated in off-farm work or off-farm economic activities. It reflects the need to augment income when one's responsibilities increases. Next, to those who have married heads are those who have heads who have married before but have separated or widowed. Majority of them, about 23%, did not participate in off-farm economic activities. Table 4.1 also shows that households who participated in off-farm activities have greater average household size, 5.9, which is approximately 6 members than those who did not with 4.6, which is approximately 5 members. This show that larger household size is associated with larger labour force participation.

Moreover, in both off-farm participation statuses, the percentage of households whose heads have no education are greater as compared to all other levels of education. This shows that more of the farm households have heads who are not educated and as well a greater percentage of them, about 46% did not participate in off-farm economic activities. This percentage is greater than the percentage of households whose heads did not also participate in off-farm economic activities but

have completed some level of education. However, among those whose heads completed some level of education and also participated in off-farm activities, greater percentage of them about 28% completed lower secondary. This is followed by those whose heads have been to primary but did not complete and those who have completed primary. The result reveals that among the few available off-farm opportunities, majority best suits those with a lower secondary. Generally, a higher proportion of the families (about 65%) who participated in off-farm economic activities have heads who have acquired some level of education. Also, university and higher-level education is the level least completed by farm household heads in this study sample.

Concerning farm production, the result shows a larger average real farm profit for household who participated in off-farm activities than farm households who did not participate, a difference of GHS 3,714. This shows that farm work may be more profitable when the household also engages or earns from off-farm activities. It may also suggest that participating in off-farm work help boost farm production, which could be through the income from off-farm or the exposure to the market that comes with participating in off-farm economic activities. However, the result shows that on average farm household who participated in off-farm economic activities made a loss of approximately GHS 29. The result also shows that on average farm household who participated in off-farm economic activities own a larger size of poultry, livestock and agriculture land than those who did not, with a difference of approximately 6 poultry, 2 livestock and 0.10 hectares respectively. The result may show that farm household who participate in off-farm economic activities are richer in terms of agricultural resources. Also, it could show that those who partake in off-farm jobs or activities, as result of their exposure to the market, are more commercial oriented and thus produce more.

Capturing households' participation in the financial sector, this study looked at household heads who have a bank account. The result shows that approximately 33% of the farm households who participated in off-farm have heads' who have a bank account as compared to approximately 20% of those who did not participate. This shows that relatively a greater percentage of households who participated in off-farm economic activities have heads who have a bank account, putting majority of them a step ahead in accessing credit. On the contrary, the average real annual remittance received is greater for those who participated in off-farm economic activities than those who did with a difference of GHS 727. Also, in terms of the proportion of total spending on food, household who participated in off-farm activities have a lesser share as compared to those who did not, a difference of approximately 5%. Based on Engel's law, the result shows that household who did not participate in off-farm economic activities are more vulnerable to food deprivation or food insecurity than those who did. The result also reveals that household who participated in off-farm or earn from off-farm spend on average more on market goods as compared to those who do not, a difference of about GHS 134,887 greater.

Finally, table 4.1 also shows the averages of the new variables introduced, which captures household expenditure on non-substitutable market goods. The result shows that expenditure on utility (electricity and gas), on housing, on health and education are on average greater for those who participated in off-farm economic activities than those who did not. The difference on average were GHS 9,904.7, GHS 59,970.2, GHS 6,474 and 67,106.8 respectively. The result also shows that in both off-farm participation statuses, farm households in Ghana spend more on education, with an average of GHS 153,885 for farm households who participated in off-farm economic activities and GHS 73,666.3 for those who did not. The result also shows that farm households in

Ghana least spend on utility, with a far lesser average (about GHS 12,181.5) for those who did not participate in off-farm economic activities.

Table 4.2 Off-farm Participation Status by Region

Region	Western	Central	Greater Accra	Volta	Eastern	Ashanti	Brong Ahafo	Northern	Upper East	Upper West
Off-farm Non-Participant										
Freq.	489	605	89	551	611	430	726	928	794	664
Percent	8.31	10.28	1.51	9.36	10.38	7.3	12.33	15.76	13.49	11.28
Off-Farm Participant										
Freq.	303	144	37	306	320	222	263	348	176	433
Percent	11.87	5.64	1.45	11.99	12.54	8.7	10.31	13.64	6.9	16.97
Total	792	749	126	857	931	652	989	1276	970	1097
Percent	9.38	8.88	1.49	10.16	11.03	7.73	11.72	15.12	11.49	13.00

In table 4.2, the study reports the regional distribution of farm households' off-farm participation status. First of all, the result shows that majority approximately 72.5% of the farm households are located in the Northern, Upper East, and Upper West, Eastern, Brong Ahafo and Volta regions of Ghana. It shows that the regions mentioned are predominantly the farming regions in Ghana. Among them, the Northern region records the highest percentage of farm households, followed by the Upper West region and Brong Ahafo region respectively. Moreover, the result also shows that in all the regions, the percentage of household who did not participate in off-farm economic activities are greater than those who did. Greater percentage of those who participate in off-farm activities out of 30.2% are located in the Upper West (5.1%), Northern (4.1%), Eastern (3.8%), Volta (3.6%) Western (3.6%) and Brong Ahafo (3.1%) respectively. These same regions mentioned together with Central and Upper East regions recorded the greater percentage of farm household who did not participate in off-farm economic activities with the Northern region recording the greatest.

4.3. Diagnostic Test Results

To ensure efficient and reliable estimates, the study conducted some diagnostic test and checks. The study tested for multicollinearity using the correlation matrix, as shown in annex (1) in the appendix. Variables which had correlation coefficients greater than 0.5 were deemed to be strongly correlated. From the matrix result, the study found strong correlation between households' marital status and sex. To correct the multicollinearity, the former, was dropped. The study also dropped the variable Off-farm profit, due to the missing information for household who did not participate in off-farm.

The study detected the presence of heteroscedasticity by comparing the values of the standard errors without applying robustness with the values of the robust standard errors. The values of the standard errors were found to be different. Thus the study settled on the robust to correct for the presence of heteroscedasticity. The result of the model without robust standard errors is shown in annex (2) in the appendix.

Falsification test was also conducted to ensure the instrument used as an exclusion restriction was relevant, valid and as well as to ensure that the model is identified. From the test, the variable which shows the hours taken to reach the closest health facility was identified as a relevant and valid instrument. It significantly influences the endogenous variable however, does not have a significant effect on the share of food expenditure and by extension the vulnerability to food insecurity of farm households who did not participate in off-farm. In theory, this variable influence the human capital base of the household and thus directly influence their investment in farm or off-farm. The variable was therefore used as an instrument. The falsification test is shown in the annex (3) in the appendix

The study also compared the result from Endogenous Switching Regression (ESR) model without instruments with the result from the model with an instrument because the model is also identified by non-linearities in the absence of an instrument. The magnitude, signs and significance of the ATT effect of off-farm participation were the same. This shows that the model employed in this study is robust even without an instrument. The results obtained from model without instrument are reported in annex (4) in the appendix.

4.4. Determinants of Off-Farm Participation and Vulnerability to food insecurity

After addressing the efficiency and reliability concerns, the study settled on the ESR with instruments. Table 4.3 reports the result of this model. It reports the determinants of off-farm and vulnerability to food insecurity for both farm households who did and did not participate in off-farm economic activities or work. It estimated the determinants using Full information maximum likelihood estimator. The study accounted for self-selection bias-based endogeneity in estimating the influence participating in off-farm economic activities on food insecurity. Self-selection bias was tested for, using the rho coefficients which shows the correlation between the disturbance terms of off-farm equation and vulnerability to food insecurity equations. The rho coefficient was found to be significant for off-farm non- participating farm households but not significant for those participating, which shows of self-selection bias existed. The result from the Wald's test for independent equations, also shows that the three equations in the model are dependent at 1% level of significance. These thus justify the use of the endogenous switching model which correct for this self-selection bias and endogeneity problems.

In terms of determinants, the ESR result reports the following: farm profit significantly decreases the probability of participating in off-farm economic activities or work at 1% level of significance. This could be clarified from the perspective that when farm production is profitable, farm

households are motivated to do more of farm production and less motivated to engage in off-farm economic activities. However, farm profit significantly increases the food expenditure share in total expenditure for both farm households who did and did not participate in off-farm economic activities. It shows that an increase in profit from farming increase the purchasing power of farm households, thus increasing their expenditure on consumption goods but more on food than non-food. This explains why food expenditure share increases with an increase in profit. It could also be because the profit from the farm is not significant enough to purchase non-food goods. Thus, it increases farm households' vulnerability to food deprivation and supports the findings of Babatunde and Qaim (2010). However, the coefficients of farm profit are very close to zero which signifies a very weak causal relationship

Real expenditure on market foods significantly increases the likelihood of farm household participating in off-farm economic activities at a significance level of 99%. The reason could be that an increase in spending comes at a cost requiring those farm households' augment their income, which then induces them to work extra including engaging in other economic activities aside farming. Real expenditure on market foods also significantly, increases the food share expenditure of farm household at a significance level of 99%. This is economically justifiable by the fact that an increase in expenditure of market foods increases the overall share of total expenditure on food. However, the relationship is much stronger for farm household who participate in off-farm work than those who do not. It could be explained by the fact that those who participate in off-farm work may be more exposed to the market and thus have access to market foods or be affected by an increase in prices than those who do not. The result implies that an increase in expenditure on market foods increases the farm households' vulnerability to food insecurity.

Table 4.3 Endogenous Switching Regression Result

Variables	Vulnerability to Food Insecurity		
	Off-farm Participation	Off-farm Participant % Food expenditure	Non-Off-farm Participant % Food expenditure
Farm and Off-farm Profitability			
Farm profit	-0.00000002** (0.0000)	0.000001*** (0.0000)	0.0000003* (0.0000)
Cost of Substitutable Market Goods			
Expenditure on market foods (log)	0.2462*** (0.0404)	7.9561*** (1.5830)	3.0468*** (0.4984)
Cost of Non-Substitutable Market Goods			
Expenditure on education (log)	0.0259*** (0.0038)	-0.6560*** (0.1843)	-0.5980*** (0.0529)
Expenditure on health (log)	0.0065* (0.0035)	-0.3251*** (0.0671)	-0.3026*** (0.0467)
Expenditure on housing (log)	0.0053 (0.0040)	-0.6936*** (0.0775)	-0.6726*** (0.0497)
Expenditure on utility (log)	0.0135*** (0.0039)	-0.2648*** (0.1021)	-0.2096*** (0.0556)
Household characteristics affecting utility and production			
Size of Household	0.0448*** (0.0069)	-0.3733 (0.2714)	-0.4051*** (0.1105)
Male-headed household	0.2262*** (0.0420)	-2.5337 (1.5740)	-2.1965*** (0.5208)
Household head has not completed Pre-school/ primary	0.2012*** (0.0491)	-0.8655 (1.4857)	-2.8253*** (0.6393)
Household head has completed primary	0.0854 (0.0526)	-1.8298* (1.0695)	-2.5574*** (0.6429)
Household head has completed lower secondary	0.2408*** (0.0457)	-1.8229 (1.6400)	-5.4301*** (0.6367)
Household head has completed upper secondary	0.0789 (0.0876)	-4.3557*** (1.6265)	-5.8259*** (1.2259)
Household head has completed post-secondary technical	-0.1009 (0.1227)	-7.8120*** (2.0711)	-10.4627*** (1.7489)
Household head has completed university and higher	-0.2468 (0.2034)	-16.7167*** (4.0668)	-16.9834*** (2.6497)
Household head has completed formal adult education	0.2370*** (0.0693)	0.8683 (1.6910)	-1.2709 (1.0129)
Size of poultry own	0.0006** (0.0003)	-0.0136 (0.0084)	-0.0002 (0.0081)
Size of agricultural land own	-0.0022 (0.0030)	-0.1427 (0.1053)	-0.0114 (0.0214)
Size of livestock own	-0.0001 (0.0003)	-0.0525*** (0.0158)	-0.0083*** (0.0025)
Household head has bank account	0.2118*** (0.0383)	-2.6398** (1.2808)	-5.0654*** (0.6046)
Lon-labor income/ Transfers			
Annual remittance received (log)	0.0133*** (0.0030)	0.0004 (-0.0926)	-0.1757*** (0.0388)

Locational Characteristics

Western region	0.3095** (0.1297)	-2.8714 (2.5420)	1.9064 (1.6817)
Central region	-0.2308* (0.1339)	2.2134 (2.3951)	4.6000*** (1.6197)
Volta region	0.3723*** (0.1307)	4.5639 (2.8307)	4.3373*** (1.6697)
Eastern region	0.3343** (0.1300)	0.7529 (2.6687)	2.3946 (1.6379)
Ashanti region	0.2055 (0.1325)	2.2576 (2.2290)	4.1669** (1.6504)
Brong Ahafo region	0.0686 (0.1322)	-0.5331 (1.9580)	5.2390*** (1.6413)
Northern region	0.1851 (0.1300)	7.7781*** (2.1761)	5.3797*** (1.6084)
Upper East region	-0.0365 (0.1326)	3.7825* (1.9574)	4.9350*** (1.5885)
Upper West region	0.6983*** -0.1337	1.9458 (4.4430)	-2.7816 (1.7679)
Urban	0.0899** (0.0435)	-5.1451*** (0.8443)	-3.4055*** (0.5750)
Instrument			
Time taken to the nearest health facility	-0.0397** (0.0195)		
Constant	-4.8979*** (0.5069)	-32.2920 (37.0313)	33.5060*** (6.3209)
Observations	8,439	8,439	8,439

/lns_1=2.5731*** /lns2=2.6961*** r1=0.2795 r2=-0.5855*** rho_1=0.2725 rho_2=-0.5266

Wald test of indep. eqns. : chi2(1) = 30.58 ***

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Being a farm household with a head who started but did not complete pre-school or primary education or who completed lower secondary or who completed adult education, increases the probability of the household participating in off-farm economic activities than those whose head has no education. The probability is however higher for those whose heads' completed lower secondary. This could be explained by the fact that off-farm opportunities available in the farming areas may require education but not beyond lower secondary. Also, maybe the returns to off-farm may not be lucrative for highly educated farm household because at higher levels beyond lower secondary the likelihood of a farm household participating in off-farm work reduces though not

significant. If the farm household head is highly educated, the household is likely to have members who are also equally educated. Such household would have the knowledge and the skill to undertake large scale or mechanised farming thus putting them in a position where they would not have to engage in other off-farm work. This result corroborates with the findings of Issahaku and Abdul-Rahaman (2018) and Abdulai and Delgado (1999). However, it contrasts that of Beyene (2008) who found out that majority of the activities available off-farm did not demand formal education in Ethiopia and as result household head level of education was found to be insignificant.

Concerning food expenditure share, as the farm household head acquires higher levels of education food expenditure share for the household reduces. This relationship is statistically significant at 1% level of significance except for those who acquired adult education. This could be explained from the perspective that education exposes the farm household to other goods and services that also maximises utility either than food. Such goods and services are cars, new clothes, tourism, recreational stuff and many others. From the result, the inverse effect on food expenditure share is greater and significant at 1% level of significance for farm households whose heads' have completed university and higher than those who have completed other levels. Thus, this result implies that education reduces household vulnerability to food insecurity, and it is very strong at university and higher levels. The relationship of the education level of a household head corroborates with the findings by Babatunde and Qaim (2010) and Issahaku and Abdul-Rahaman (2018).

Household size also significantly increases the probability of farm household participating in off-farm economic activities at a 1% level of significance. This could be explained from the perspective that a larger household comes with a larger labour force both for farm and off-farm. It could also lead to excess labour which could be allocated to off-farm work. This relationship

supports the findings of Abdulai and Delgado (1999) but contrasts that of Tsiboe et al. (2016) both in Northern Ghana. However, in terms of food share, household size reduces it, but only significant for those who did not participate in off-farm economic activities. The relationship was nevertheless not as expected. The reason could be that an increase in household size increases off-farm participation and thus income of the farm household and put farm households in a position where they could afford more non-food goods. Thus contributing to a reduction in food expenditure share and by extension, reduce farm household vulnerability to food insecurity.

Size of poultry owned by the farm household increases the probability of farm household engaging in off-farm economic activities, and it is statistically significant at 5% level of significance. This result is opposite to what the study expected, and the relationship is weak because the coefficient is close to zero. The study expected that as the size of poultry increases the farm household would be more engaged in taking care of them and as a result would not have enough time to engage in off-farm work. However, the result showed the opposite, which could be justified from the perspective that when the size of poultry owned increases farm household may employ others with the requisite skills to take care of them while they engage in other off-farm works. In such a case, an increase in the size of poultry is likely to increase the likelihood of off-farm participation.

Moreover, this explanation could be supported by the fact that the average size of poultry owned by farm households who participated in off-farm work is higher than those who did not. Concerning the proportion of total spending on food, an increase in the size of poultry owned by farm household reduces the proportion of total spending on food. The relationship is stronger for those who participate in off-farm but not statistically significant. This could be explained by the fact that farm households are more likely to commercialise their poultry size increases. Especially for those who work off-farm since they are more exposed to the market, stand a better chance of

making good sales than those who do not. This result indicates that an increase in the size of poultry owned reduces food expenditure share and in effect, reduces vulnerability to food insecurity for farm households in Ghana.

Male-headed farm households are more likely to participate in off-farm work than female-headed farm households and were statistically significant at 1% level of significance. This could be explained by the fact that generally in low-income countries like Ghana, men have better employment opportunities than women. This corroborates with Beyene (2008) who also found out that male-headed households have higher chances of participating in off-farm work than female-headed-households. Concerning the share of food expenditure, being a male-headed farm household reduces it than being a female-headed farm household but only significant for those who do not participate in off-farm. This could be explained by the fact that male-headed farm households are more affluent than female-headed ones in farming areas in Ghana and also most African countries. Thus putting them in a better position to afford more of other expenditures other than food. Thus being headed by a man as a farm household reduces vulnerability to food insecurity than being headed by a woman.

The size of agricultural land owned reduces the likelihood of farm household participating in off-farm and the share of food expenditure in total expenditure for both farm households who participated in off-farm work and those who do not. The result supports the findings obtained by Issahaku and Abdul-Rahaman (2018), which found farm size to negatively related to off-farm participation. This result is economically justifiable because larger agricultural land sizes increase agricultural production and thus farm participation. It also increases output and income from agriculture which can be used to purchase other non-food household needs, as expected by Engel's laws as income grows. However, the relationship is not statistically significant. This could be

explained by the fact that land sizes in Ghana barely changes because they are not privately owned. As such cannot just be increased by an individual farm household because it involves a tedious process of consulting traditional leaders. The land tenure system is the customary type where agricultural lands together with some non-agricultural lands are owned by the stool or the traditional leaders. This cast light on how detrimental the tenure system is to agricultural production in the country.

Size of livestock owned by the farm household reduces the likelihood of farm household engaging in off-farm work which is per what was expected. A larger size of livestock increase farm household participating in livestock rearing and reduces the time available for off-farm work. This relationship contrasts the result obtained by Abdulai and Delgado (1999) and Issahaku and Abdul-Rahaman (2018). However, this was not statistically significant and could be explained by the fact that the effect is weak because the coefficient is very close to zero and as well those who participated in off-farm rather have a larger average size of livestock. About the share of food expenditure, a larger size of livestock reduces it, thus reduces household vulnerability to food insecurity at 1% level of significance. This could be explained by the fact that larger livestock leads to increase in income through sales which can be used to purchase non-food items since the farm household already produce food from the farm. The effect of the number of livestock on the food expenditure share is greater for household who participated in off-farm than those who did not. This could suggest that those who participated in off-farm are again more exposed to the market and as a result stand better chance of making good sales from the market than those who do not.

Also, farm households whose head have a bank account are more likely to participate in off-farm work than those whose head does not have a bank account, and it is significant at 1% level of

significance. This is possible because having a bank account shows the households' participation in the financial market. This makes it less complicated for the household to access credit for their off-farm work and also farm work, especially from microfinance institutions. This supports the findings of Owusu et al. (2011), who found that access to credit increases off-farm participation. With food expenditure share, being a farm household whose head has bank account reduces the share of food expenditure, and it is statistically significant. This could be explained by the fact that such households can fall on credits packages from the bank for non-food expenditures such as education or would save instead of spending on food. The relationship is, however, stronger and highly significant for those who did not than those who did participate in off-farm economic activities.

Real annual remittance received significantly increases the likelihood of farm household participating in off-farm work at 1% level of significance. This could be explained by the fact that remittance income help increases household investment in off-farm work, through an increase in the human capital and asset base such as land and livestock (World Bank, 2008). This relationship, however, contrasts the result obtained by Abdulai and Delgado (1999). In terms of food expenditure share, real annual remittance received reduces it, thus reducing farm households' vulnerability to food deprivation for farm households who do not participate in off-farm. On the contrary, for those who do engage in off-farm, real annual remittance received increase food expenditure share, thus increasing their vulnerability to food insecurity. However, it is only significant for those who do not, and it is at 1% level of significance. This could be a result of the amount involved, which could not be huge enough to effect any significant change in food share for those who participate in off-farm since they may be already better off as compared to those who do not participate.

Farm households which are located in the urban areas have a higher likelihood of participating in off-farm work than those who are located in the rural areas, and it is statistically significant at 5% level of significance. This is explained by the fact that farm household who are located in the urban areas have access to more off-farm work opportunities than in the rural areas. It could also be due to the pressure on the limited agricultural land resources and also the low returns from farming to cater for living expenses in these areas, forcing farm household to engage more in off-farm work (World Bank, 2008). The result also shows that being located in an urban area as a farm household reduces the proportion of total spending on food as compared to being located in the rural area at 1% level of significance. Thus it reduces households' susceptibility to being food insecure. The relationship is, however, stronger for those who participated in off-farm than those who did not participate in off-farm economic activities. This again suggests that farm household who participate in off-farm work have access to more non-food commodities and service. It also suggests their higher degree of exposure to the market where these other non-food items can be obtained. This relationship between urban dwellers and food insecurity corroborates with Salifu et al., (2016), who found that food insecurity is a rural problem in northern Ghana.

Farm households which are located in Western, Upper West, Volta, and Eastern regions of Ghana are more likely to participate in off-farm than those who are located in Greater Accra region at 5% level of significance. For Western, Upper West, Volta and Eastern regions, this could be explained using the result from table 4.2 and 4.1. Table 4.2 shows that majority of the farm households are found in these regions and table 4.1 shows that most of the farm households have heads who either no education, completed adult education, did not complete primary or completed lower secondary. Also, from the result of education on off-farm participation, these levels of education were strong positive determinants of off-farm participation as compared to those who have no education. Also,

more of the farm households in Western, Upper West, Volta and Eastern regions participate in off-farm activities which induce the other farm households also to participate. Thus, increasing the likelihood of farm household located in this area to participate. However, in the Central region, farm households are more likely not to participate than in the Greater Accra region and its statistically significant at 10% level of significance. This could be explained by the fact that few of the farm households located in the region participate and thus the tendency to be influenced by other farm households is low (see table 4.2). It could also be explained by the non-profitability of the off-farm sector as shown by the average profit in table 4.1.

Hours taken to reach the closest health facility reduces the likelihood of farm household participating in off-farm work at 5% level of significance. The facilities in the survey included any place where health consultation was acquired such as hospitals, clinics, CHIPS, traditional healers, homes of the expert or the practitioner, chemical or pharmacy shops, among others. This is explained by the fact that the longer the time required to reach the health centre, the lesser the time available for one to work both in off-farm and farm after treatment. Also, the farther away health centres are from the farm households, the higher the likelihood of the household being in their adverse condition for long and thus reducing their ability to work extra outside their farm. Generally, hours taken to reach nearest health care centre reduces the quality and also quantity of human capital at any point in time

Finally, to capture the effect of expenditure on non-substitutable market goods on off-farm participation, the study included expenditure on health, utility, education and housing in the model. The outcome showed that expenditure on health, utility and education positively and significantly influence farm households' off-farm participation likelihood. This could be explained by the fact that these are basic living expenses, as their expenditure increases it could reflect an increase in

the cost of living and thus the need to engage in extra work to augment farm income. Expenditure on housing was, however, not statistically significant. This could be explained by the fact that farm households, especially those found in rural areas usually live in their own built houses and do not spend much on rent. Moreover, they barely spend on furnishing their houses since mostly the quality of materials and floors are poor and not the type that requires fancy furnishing.

4.5 Effect of Off-Farm on Farm Household Vulnerability to Food Deprivation

To account for the implication of participating in off-farm economic activities affect households' food insecurity status, the study made use of the conditional expectation in ESR to compute the expected proportion of total spending on food in the case of observed and their counterfactuals. These were the expected proportion of total spending on food for farm household who participated in off-farm work and the counterfactual case if they had not participated. The expected proportion of total spending on food for farm household who did not participate in off-farm work and the counterfactual case if they did. The results are reported in table 4.4

The results indicates that the expected proportion of total spending on food for farm household who participated in off-farm work was 54.69% and if they did not participate (counterfactual) is 60.07%. Thus yielding an average treatment effect on the treated as -5.37%, which implies that if farmers who participated, did not, their proportion of total spending on food would have increased by 5.37%. This suggests that they would have increased their vulnerability to food insecurity, thus participating in off-farm reduces the vulnerability to food deprivation of farm households. This supports the findings of Issahaku and Abdul-Rahaman (2018) Kuwornu et al. (2018), Owusu et al. (2011) and Zereyesus et al. (2016) who found that off-farm participation improves household food security status. On the contrary, this result contrasts that of Tsiboe et al. (2016), Holden et al., (2004) and Dzanku and Sarpong (2014).

The results also reveals that the expected proportion of total spending on food for farm household who did not participate in off-farm work was 43.96% and if they did participate was 51.85%. Thus, also yielding the average treatment effect on the untreated as 7.88% which implies that if farmers who did not participate did, their proportion of total spending on food would have increased by 7.88%. This ATU, however, suggests an opposing implication to that of ATT, that off-farm participation increases farm household vulnerability to food insecurity. This on the other hand, supports the findings of Tsiboe et. al. (2016), Bayene (2008), Dzanku and Sarpong(2014) and World Bank (2008) but opposes that of Issahaku and Abdul-Rahaman (2018), Kuwornu et. al. (2018), Owusu et. al. (2011) and Zereyesus, et. al. (2016). This could reflect their market exposure or their off-farm exposure and off-farm skill, which in turn reflects how much they would earn from off-farm.

Given that non-food are more expensive than food, if income earned from off-farm is not significant, participating will instead end up increasing food share through the purchase of staples and thus increase vulnerability to food insecurity. This could be so if the farm household is not well skilled in relation to off-farm work or not well exposed to the off-farm market, which farm households who work only on the farm are likely to be. This is because a greater percentage of those who did not participate have heads who have no education and higher levels the percentages are lesser compared to those who did participate in off-farm work (see table 4.1). The level of education of the head much reflects the level of education, skills and amount off-farm work opportunities of the household. Moreover, table 4.1 also shows that a greater percentage of farm households who did not participate in off-farm work are located in rural areas where off-farm opportunities are limited as compared to those who did participate.

Also, relatively, most of them are headed by females and given that women have fewer work opportunities reduces the households' chances of getting off-farm work among the few opportunities available in rural areas. Moreover, in table 4.1, the result shows that most farm households who are not engaged in off-farm work own relatively smaller size of agricultural land, livestock and poultry, implying their scale of production is small which also reduces their ability to earn enough from sales. In such case concentrating on farming where they are skillful and improving on their productivity would instead increase output and income more significantly than dividing their time for both off-farm and on-farm work. In short, they have comparative advantage on the farm.

The results also reports the heterogeneity effect of participating in off-farm economic activities. The transition heterogeneity was found to be positive which implies that, if farm households who did not participate in off-farm work did participate, they would have had the proportion of total spending on food increased. Thus they would have been more vulnerable, which implies they are better off on the farm only than engaging in economic activities outside the farm alongside farming. The impact of not participating in off-farm on vulnerability to food insecurity is significantly larger for farm households who did not participate in off-farm work relative to farm households who did. Farm households who participated in off-farm work would have been more vulnerable to food insecurity in the counterfactual case (20d) than those who did not. In other words, farm households who participated in off-farm work are better off in terms of vulnerability to food insecurity (less vulnerable) than if they did not. This suggests the existence of some relevant sources of heterogeneity which put farm households who did not participate in off-farm work at a comparative advantage (more productive) in farming over those who participate in off-farm work. Thus the mass movement of farm household into the off-farm sector, in the manner

being experienced now, without considering the skill and education requirement is not efficient. This corroborates Kuwornu et al. (2016) and Carletto et al. (2015) who found out that on-farm production help reduce food security and nutrition than working off-farm. The ATU result, also supports Salisu et al. (2016), who discovered that food insecurity in the northern region rural productivity problem and an issue of poverty.

4.8 Effect of Off-Farm on Farm Household Vulnerability to Food Insecurity

Sample	Decision Stage			t-value
	To participate	Not to participate	Effects	
	20(a)	20(d)	ATT	
Farm household who participated in off-farm	54.69 (0.1727)	60.07 (0.0981)	-5.37*** (0.1875)	-28.6719
	20(c)	20(b)	ATU	
Farm household who did not participate in farm	51.85 (0.1430)	43.96 (0.1238)	7.88*** (.2320)	33.9759
	HT1	HT2	TRH	
Heterogeneity effect	10.73*** (0.2124)	8.22*** (0.1735)	2.51***	t1=11.145 t2=47.399
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATION

This chapter presents the summary and conclusions based on the objectives set out to be achieved by this study as well as the policy recommendations based on the findings obtained.

5.1 Summary

This paper set out to investigate the determinants of off-farm participation and its effect on farm household vulnerability to food deprivation. It made use the percentage of food expenditure in total expenditure as a measure of vulnerability based on Engel's law. It is approved by the Food and Agricultural Organization (Smith, 2012) and International Food Policy Research Institute (Smith and Subandoro, 2007) when using household income and expenditure survey data, like that of Ghana Living Standard Survey used in this study.

In relation to the determinants of off-farm participation, the study found that farm profit, hours are taken to reach the closest health facility and being a farm household locate in Central region other than Greater Accra significantly reduce the likelihood of farm households participating in off-farm work. On the other, expenditure on market foods, being a farm households whose head started but did not complete pre-school or primary education, completed lower secondary, completed adult education, household size, number of poultry owned by the farm household, male-headed farm households, being a farm households whose head have a bank account and real annual income from remittance significantly increases the likelihood of farm households participating in off-farm work. Also, being a farm household located in the urban area, Western, Upper West, Volta, and Eastern regions of Ghana significantly increase the likelihood of the farm households participating in off-farm work. This paper included expenditure on non-substitutable market goods as a

modification to the time allocation model, among these, expenditure on health, utility, education were found to significantly increase the likelihood of participating in off-farm work, with the relationship being stronger with utility. The result confirms that it is misleading to assume that home or farm-produced goods are perfect substitutes.

Concerning how participating in off-farm economic activities affect households' vulnerability to food insecurity, the study found out from the ATT that farm households which did participate in off-farm work would have had their food expenditure share in total expenditure increased by 5.37% if they did not. Thus making them more vulnerable to food insecurity. On the contrary, the study also found out from ATU that farm households who did not participate in off-farm work would have had their food expenditure share in total expenditure increased by 7.88%. Thus, making them more vulnerable to food insecurity, and it is confirmed by the result from the heterogeneity effect. This results showed that farm households who only work on the farm have a comparative advantage on the farm and that they would have been worse off if they did participate in off-farm. These results (ATT and ATU) seconds both the proponents "for" and proponents "against" the debate that off-farm participation improves farm household welfare. Specifically, it shows that whether off-farm participation will improve the welfare of the farm household or not, depends on which side the farm household has comparative advantage, on the farm only or sharing their time between farm and off-farm gave its education and opportunities available.

5.2. Conclusion

This study, therefore, concludes from the above findings that off-farm participation may or may not improve farm household vulnerability to food insecurity depending on the comparative advantage of the farm households. Farm households who have a comparative advantage in working both in off-farm and on-farm would be better off participating in off-farm alongside their farm

work. Farm households who have a comparative advantage on the farm only due to factors such as education, skill and financial constraints, would be better off concentrating on the farm and improving production. The study also concludes that expenditure on or cost of non-substitutable market goods have a significant positive influence on farm households' off-farm participation decision

5.2 Policy Recommendation

The study recommends that off-farm economic activities be considered in poverty reduction interventions by government, international bodies and stakeholders. However, the interventions must take into consideration the comparative advantage in production of the farm households in the various areas the policies may intend to be implemented. In areas where farm households are well educated, more off-farm work opportunities should be made available, and where education and skill is relatively low and off-farm opportunities are limited, farm households should be assisted to expand farm production or become more productive through the provision of fertilizers, improved seeds. Land reforms would be necessary to help increase their farm sizes, irrigation dams would ensure all year-round cultivation. By this, the country will be able to ensure efficient reallocation of farm labour and inclusive growth without the farmers being left behind.

The study also recommends that interventions should also capture goods or needs such as education, health and utility as well as other non-substitutable market goods. More explicitly concerning cost of education, health and utility, measures must be taken to reduce them as they help to improve the quality of the farm households' human capital and reduce the cost of living.

REFERENCES

- Abdulai, A & Delgado, C. L. (1999). Determinants of Nonfarm Earnings of Farm-Based Husbands and Wives in Northern Ghana. *American Journal of Agricultural Economics* 18(1), 117-130.
- AGRA. (2017). *African Agricultural Status Report: The Business of Small Holder Agriculture in Sub-Saharan Africa*. (Issue 5). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA). Issue No. 5
- Awetori, J.Y. (2006). Is Deagrarianisation Real? A Study of Livelihood Activities in Rural Northern Ghana. *The Journal of Modern African Studies*, 44(1), 125-156.
- Ayala, F. V. (2010). *LEAP; For the Protection and Promotion: The Design and Implementation of Effective Social Safety Nets*. Paper presented at the World Bank Social Protection Conference, Washington, D.C. HQ-C, USA. Retrieved from: <https://siteresources.worldbank.org/SAFETYNETSANDTRANSFERS/Resources/281945-1131468287118>
- Babatunde, R. O., & Qaim, M. (2010). Impact of Off-Farm Income on Food Security and Nutrition in Nigeria. *Food Policy*, 35, 303–311
- Barbier, E., & Hochard, J. (2017). Poverty, Rural Population Distribution and Climate Change. *Environment and Development Economics*, 1–23.
- Beyene, A. D. (2008) Determinants of off-farm participation decision of farm households in Ethiopia. *Agrekon: Agricultural Economics Research, Policy, and Practice in Southern Africa*, 47(1), 140-161.
- Bila, Y., Mshelia, B. S., & Landi, J. H. (2015). Off-Farm Activities and Its Contribution to Household Income in Hawul Local Government Area, Borno State, Nigeria. *IOSR Journal of Agriculture and Veterinary Science*, 8(10), 09-13
- Carletto, G., Ruel, M. T., Winters, P., & Zezza, A. (2015). Farm-Level Pathways to Improved Nutritional Status. *The Journal of Development Studies*, 51(8), 12-24
- De Luca, G. (2008). SNP and SML Estimation of Univariate and Bivariate Binary-Choice Models. *Stata Journal* (8), 190–220.
- Darfour, B., & Rosentrater, K. (2016). *Agriculture and food security in Ghana*. In Proceedings of the American Society of Agricultural and Biological Engineers (ASABE) International Meeting, Orlando, FL, USA, 17–20 July 2016

- Dittoh, D. (2016). Assessing the impact of Livelihood Empowerment Against Poverty Programme in the Naddam district of Ghana. International Institute of Social Studies.
- Dutoit, L. C. (2007). Heckman's Selection Model, Endogenous and Exogenous Switching Models: A Survey. Unpublished, University of Lausanne.
- Dzanku, F. M. (2015). Household Welfare Effects of Agricultural Productivity. A Multi-dimensional Perspective from Ghana. *Journal of Development Studies*, 51(9), 1139-1154
- Dzanku, F. M. & Sarpong, D. B. (2014). Household-Level Farm-Nonfarm Linkages and Household Welfare Implication.
- Egyei, R.K. & Adzevour, P.H.Y. (2013). Household Non-Farm Income: Any Influence On Agricultural Productivity in Rural Ghana. *Developing Countries studies* 3(9), 79-90.
- Ellis, F., & Mdoe, N. (2003) Livelihoods and Rural Poverty Reduction in Tanzania. *World Development Report*, 31(8), 1367-1384.
- Ellis, F. (2000). The Determinants of Rural Livelihood Diversification in Developing Countries *Journal of Agricultural Economics*, 51(2), pp289-302
- FAO, G. R. (2015). *The Economic Lives of Small Holder Farmers. An Analysis Based On Household Data from Nine Countries*. Food and Agricultural Organization of the United Nations, Rome, Italy
- Findeis, J. L., Swaminathan, H., & Jayaraman, A. (2003). Agricultural Household-Firm Units: Adjustments to Change. *Workshop on Agricultural Policy Reform and Adjustment Imperial College, Wye*.
- Fleming, C. M., & Kler, P. (2008). I'm Too Clever for This Job: A Bivariate Probit Analysis On Overeducation and Job Satisfaction in Australia. *Applied Economics*, 40(9), 1123-1138
- Greene, W. H. (2012). *Econometric Analysis International Edition* (7th Ed.). UK: Pearson Education Limited
- Ghana Investment Promotion Centre (2018). Agriculture Information for the Public. Retrieved from: http://www.gipc.gov.gh/gipcsite/?Page_21-34
- Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF. 2017. *Ghana Malaria Indicator Survey, 2016*. Accra, Ghana, and Rockville, Maryland, USA: GSS, GHS, and ICF.F.D.

- GSS (Ghana Statistical Service) 2014: *Ghana Living Standard Survey Sixth Report 2012-2013, Accra: GSS.*
- GSS (Ghana Statistical Service) 2013: *2010 Population & Housing Census: National Analytical Report, Accra: GSS*
- GSS (Ghana Statistical Service) 2017: *Ghana Living Standard Survey Sixth Report 2012-2013: Labour force report, 2014, Accra: GSS*
- GSS (Ghana Statistical Service) 2018: *Ghana Living Standard Survey Seventh Report 2015-2017, Accra: GSS.*
- Haddad, L. J., & Bouis, H. E. (1991). The Impact of Nutritional Status on Agricultural Productivity: Wage Evidence from the Philippines. *Oxford Bulletin of Economics and Statistics*, 53(1), 0305-9049
- Herforth, A., Nicolo, F.G., Veillerate, B., & Dufour, C. (2016). *Compendium of Indicators for Nutrition-Sensitive Agriculture- Final Draft. Rome, Italy: Food and Agricultural Organization of the United Nations*
- Heckman, J. (1974). Shadow Prices, Market Wages, and Labor Supply. *Econometrica*, 42(4), 679-694.
- Holden, S., Shiferaw, B., & Pender, J. (2004). Non-Farm Income, Household Welfare, and Sustainable Land Management in a Less-Favored Area in the Ethiopian Highlands. *Food Policy*, 29 (2004), 369–392.
- Huffman, W. E. (1980). Farm and Off-Farm Work Decisions: The Role of Human Capital, *Review of Economics and Statistics*. 62 (1), 14-23.
- Huffman, W. E. (2004). Discussion: Off-Farm Employment, Government Policy, And the Structure of Agriculture—An International Perspective. *American Journal of Agricultural Economics*, 86(3), 737–739.
- INDDEX Project. (2018). *Data4Diets: Building Blocks for Diet-related Food Security Analysis.* Tufts University, Boston, MA.
- Issahaku, G., & Abdul-Rahaman, A. (2018). Sustainable Land Management Practices, Off-Farm Work Participation and Vulnerability among Farmers in Ghana: Is There A Nexus? *International Soil and Water Conservation Research.*

- Janvry, D. A., & Sadoulet, E. (2001). Income Strategies among Rural Household in Mexico. The Role of Off-Farm Activities. *World Development*, 29(3), 467- 480
- Jacoby, H.G. (1993). Shadow Wages and Peasant Family Labour Supply: An Econometric Application to the Peruvian Sierra. *The Review of Economic Studies*, 60(4), pp903-921
- Kuwornu, J. K. M. (2018). Off-Farm Work and Food Security Status of Farming Households In Ghana. *Development in Practice*
- Kuwornu, J. K. M., Osei, E., Osei-Asare, Y. B., & Porgo, M. (2016). Analysis of Food Security Status of Farming Households in the Forest Belt of the Central Region of Ghana. *Russian Journal of Agricultural and Socio-Economic Sciences*, 1(13), pp26-42
- Maddala G.S., & Nelson, F.D. (1975). Switching Regression Models with Exogenous and Endogenous Switching in Econometric Methods and Applications. *Edward Elgar Publishing Limited*, 3, 423-426.
- Mata, S. H. C., Zafarullah, A., Jalilb, A., & Harunc, M. (2012). Does Non-Farm Income Improve Poverty and Income Inequality Among Agricultural Household in Rural Kedah? *Procedia Economics and Finance*, 1, 269 – 275
- McCarthy, N., & Sun, Y. (2009). Participation by Men and Women in Off-Farm Activities. An Empirical Analysis of Rural Northern Ghana. *Int. Food Policy. Res. Inst.*, 552
- Michael Lokshin, M., & Zurab Sajaia, Z. (2004). Maximum likelihood estimation of endogenous switching regression models. *The Stata Journal*, 4(3), 282–289
- Ministry of Food and Agriculture (MoFA), Republic of Ghana. (2017). *Planting for Food and Jobs; Strategic Plan for Implementation (2017-2020)*. Retrieved from: <https://mofa.gov.gh/site/wpcontent/uploads/2018/03/PFJ%20documents%20New%20new.pdf>
- Musah, A., Ibrahim, M., & Adam, I. O. (2016). Poverty, Income Diversification and Welfare in Northern Ghana. *Journal of African Political Economy & Development*, 1(1), 76-102
- Ndwiga, J. M. (2019) Sustainable Land Management Technologies and Poverty in Kenya. *Climatol Weather Forecasting*, 247 (7).
- Nicholson, W., & Snyder, C. (2008). *Microeconomic Theory Basic Principles and Extensions* (10th Ed.). USA: Thomson Higher Education
- Owusu, V., Abdulai, A., & Abdul-Rahman, S. (2011). Non-Farm Work and Food Security among Farm Households in Northern Ghana. *Food Policy*, 36, 108–118

- Quartey, F. A. (2018). *LEAP: Impact and Linkage to Healthcare Access; Evidence from Ghana*. Paper presented at the Social Protection Conference, Kenya. Retrieved from: <https://spc.socialprotection.or.ke/images/downloads/presentations/Florence-Ayisi-Quartey-LEAP-Impact-Linkages>
- Rahut, D. B., & Scharf, M. M. (2012). Livelihood Diversification Strategies in the Himalayas. *The Australian Journal of Agricultural and Resource Economics*, 56, 1-25
- Salisu, M., Tanko, M., & Alidu, A. (2016). Determinants of Household Food Insecurity in Northern Ghana: An Ordered Probit Approach. *Journal of Economics and Sustainable Development*, Vol. 7, No. 16, 2016.
- Senadza, P. (2011): Does Non-Farm Income Improves or Worsens Income Inequality? Evidence from rural Ghana. *African Review of Economics and Finance*. 2(2),104-121.
- Shehua, A. & Sidiquea, S. F. (2014). A Propensity Score Matching Analysis Of The Impact Of Participation In Non-Farm Enterprise Activities On Household Wellbeing In Rural, Nigeria. *UMK Procedia*, 1, 26 – 32
- Singh, I., Squire, L., & Strauss, J. (1986). *Agricultural Household Models Extensions, Applications and Policy*. Baltimore: The Johns Hopkins University Press.
- Skoufias, E. (1994). Market Wages, Family Composition and The Time Allocation Of Children in Agricultural Households. *The Journal of Development Studies*, 30(2), 335-360.
- Skoufias, E. (1994). Using Shadow Wages to Estimate Labor Supply of Agricultural Households. *American Journal of Agricultural Economics*. 76, 215-227
- Smith, L. C. (2012). *The Use of Household Expenditure Surveys for the Assessment of Food Insecurity*. International Food Policy Research Institute, Washington, DC, USA
- Smith, L.C., & Subandoro, A. (2007). *Measuring Food Security Using Household Expenditure Surveys. Food Security in Practice technical guide series*. Washington, D.C.: International Food Policy Research Institute.
- Takahiro, I. & Kurosaki, T. (2009). Weather Risk, Wages in Kind and Off-Farm Labor Supply of Agricultural Households in a Developing Country. *American Journal of Agricultural Economics*, 91(3), 697-710
- Thorn, T. (2011). *Testing for Heteroscedasticity in Bivariate Probit Models* (Doctoral Dissertation).
- Tsiboe, F., et al. (2016). Non-farm work, food poverty, and nutrient availability in northern Gha-

na. *Journal of Rural Studies*, 47, 97-107

United Nation (2019). *World food programme, Ghana country brief*. World Food Programme

Vakis, R., Sadoulet, E., de Janvry, A., & Cafiero, C. (2004). Testing For Separability in Household Models with Heterogeneous Behavior: A Mixture Model Approach

World Health Organization. (2018). *The state of food security and nutrition in the world 2018: Building climate resilience for food security and nutrition*. Food and Agricultural Organization

World Bank. (2008). *World development report 2008: Agriculture for development*. World Bank

World Bank. (2018). Overview: Understanding Poverty. Retrieved from <http://www.worldbank.org/en/topic/poverty/overview>

Yograj, G. & Anderson, P. (2016). Rural Livelihood Diversification and Household Well-Being. Insight from Humlu, Nepal. *Journal of Rural Studies*, 44, 239-249

APPENDIX

Annex 1: Correlation Matrix

Variables	Expenditure on market foods (GHS)	Annual remittance received (GHS)	Size of Household	Farm profit (GHS)	Size of poultry own	Size of agricultural land own	Size of livestock own	Expenditure on utility (GHS)	Expenditure on education (GHS)	Expenditure on healthcare (GHS)	Expenditure on Housing (GHS)	Male-headed household	Household with never married-head	Household with married-head	Household with divorced-head	Household head has no education	Household head has not completed Pre-school/primary	Household head has completed primary
Expenditure on market foods (GHS)	1.00																	
Annual remittance received (GHS)	0.13	1.00																
Size of Household	0.24	-0.02	1.00															
Farm profit (GHS)	0.03	-0.01	0.11	1.00														
Size of poultry own	0.04	-0.01	0.07	0.20	1.00													
Size of agricultural land own	0.11	0.16	0.03	0.03	0.04	1.00												
Size of livestock own	0.00	-0.01	0.10	0.02	0.03	0.00	1.00											
Expenditure on utility (GHS)	0.13	0.05	0.02	-0.01	0.02	0.01	-0.01	1.00										
Expenditure on education (GHS)	0.29	0.07	0.28	0.04	0.05	0.02	0.01	0.12	1.00									
Expenditure on healthcare (GHS)	0.24	0.02	0.09	0.06	0.01	0.03	-0.01	0.04	0.10	1.00								
Expenditure on Housing (GHS)	0.16	0.04	0.04	0.01	0.01	0.02	0.00	0.29	0.12	0.09	1.00							
Male-headed household	0.04	-0.10	0.23	0.05	0.05	0.04	0.06	-0.01	0.03	0.02	0.02	1.00						
Household with never married-head	-0.11	0.01	-0.21	-0.02	-0.02	-0.02	-0.02	-0.01	-0.05	-0.05	-0.01	0.04	1.00					
Household with married-head	0.11	-0.07	0.36	0.05	0.05	0.04	0.06	0.00	0.08	0.05	0.03	0.61	-0.35	1.00				
Household with divorced-head	-0.07	0.07	-0.28	-0.04	-0.04	-0.03	-0.06	0.00	-0.06	-0.03	-0.02	-0.66	-0.10	-0.90	1.00			
Household head has no education	-0.12	-0.02	0.10	-0.01	-0.01	0.00	0.04	-0.06	-0.14	-0.06	-0.06	-0.10	-0.08	-0.04	0.08	1.00		
Household head has not completed Pre-school/primary	-0.01	-0.01	-0.02	0.00	-0.01	-0.02	-0.01	-0.02	-0.03	-0.01	-0.01	-0.03	0.00	-0.02	0.02	-0.33	1.00	
Household head has completed primary	0.01	0.00	-0.07	-0.01	-0.01	0.00	-0.02	0.01	-0.02	-0.01	-0.01	0.00	0.06	-0.03	0.00	-0.31	-0.14	1.00
Household head has completed lower secondary	0.10	0.00	-0.06	0.02	0.03	0.01	-0.02	0.04	0.14	0.06	0.05	0.11	0.01	0.08	-0.09	-0.46	-0.20	-0.19
Household head has completed upper secondary	0.04	0.00	-0.04	-0.01	0.01	0.01	-0.01	0.03	0.07	0.00	0.06	0.08	0.09	0.03	-0.07	-0.16	-0.07	-0.07
Household head has completed post-secondary technical	0.07	0.04	-0.02	0.02	-0.01	0.01	-0.01	0.05	0.07	0.05	0.03	0.03	0.01	0.02	-0.03	-0.11	-0.05	-0.05
Household head has completed university and higher	0.06	0.11	-0.03	-0.01	-0.01	0.00	0.00	0.07	0.07	0.02	0.06	0.03	0.04	0.00	-0.02	-0.07	-0.03	-0.03
Household head has completed formal adult education/litarcy program	-0.01	0.01	0.06	0.00	0.01	-0.01	0.02	-0.01	-0.01	0.01	-0.02	-0.03	-0.03	-0.02	0.03	-0.21	-0.09	-0.09
Household head has bank	0.17	0.07	0.03	0.04	0.05	0.05	0.00	0.09	0.18	0.09	0.07	0.09	0.02	0.09	-0.10	-0.25	-0.02	0.01
Western	0.10	0.00	-0.04	0.02	-0.02	0.01	-0.04	0.02	0.10	0.07	0.02	0.00	0.02	-0.01	0.00	-0.14	0.01	0.06
Central	0.12	-0.02	-0.07	-0.02	-0.03	0.00	-0.04	-0.01	0.05	0.01	0.01	-0.07	-0.01	-0.06	0.07	-0.07	0.00	0.02
Greater Accra	0.09	0.04	-0.02	-0.04	-0.01	-0.01	-0.01	0.04	0.03	0.02	0.04	-0.01	0.00	-0.01	0.01	-0.03	0.03	0.00
Volta	0.02	0.01	-0.03	0.00	-0.01	-0.03	-0.02	0.01	-0.05	0.00	0.00	-0.04	-0.01	-0.03	0.04	-0.09	0.01	0.02
Eastern	0.04	0.01	-0.10	-0.01	-0.01	0.00	-0.03	-0.01	0.03	0.01	0.01	-0.02	-0.01	-0.03	0.04	-0.15	0.04	0.06
Ashanti	0.08	0.04	-0.06	0.01	-0.01	0.01	-0.03	0.04	0.04	0.03	0.02	-0.06	-0.02	-0.05	0.06	-0.10	0.01	0.03
Brong Ahafo	-0.07	0.06	-0.01	0.09	0.06	0.04	-0.02	0.02	0.06	0.03	0.01	-0.02	0.02	-0.02	0.01	-0.06	0.00	0.02
Northern	-0.03	-0.05	0.16	0.00	0.01	0.03	0.06	-0.02	-0.07	0.02	0.01	0.15	-0.01	0.13	-0.13	0.23	-0.07	-0.07
Upper East	-0.04	-0.02	-0.01	-0.04	0.02	-0.03	0.03	-0.02	-0.06	-0.06	-0.03	-0.01	-0.02	0.02	-0.02	0.16	-0.01	-0.05
Upper West	-0.20	-0.03	0.12	-0.03	-0.01	-0.02	0.07	-0.03	-0.09	-0.10	-0.05	0.03	0.03	0.02	-0.04	0.16	0.00	-0.07
Rural area	-0.19	-0.12	0.07	0.04	-0.01	-0.01	0.04	-0.14	-0.15	-0.03	-0.13	0.08	-0.02	0.07	-0.06	0.07	0.01	0.00
Urban area	0.19	0.12	-0.07	-0.04	0.01	0.01	-0.04	0.14	0.15	0.03	0.13	-0.08	0.02	-0.07	0.06	-0.07	-0.01	0.00
Time taken to reach the closest health facility	0.06	0.01	-0.02	-0.01	0.00	0.00	0.00	0.01	0.01	0.03	0.01	-0.03	-0.02	-0.03	0.04	-0.02	0.00	0.00

	Household head has completed lower secondary	Household head has completed upper secondary	Household head has completed post-secondary technical	Household head has completed university and higher	Household head has completed formal adult education/litarcy program	Household head has bank account	Western	Central	Greater Accra	Volta	Eastern	Ashanti	Brong Ahafo	Northern	Upper East	Upper West	Rural area	Urban area	Time taken to reach the closest health facility	
Household head has completed lower secondary	1.00																			
Household head has completed upper secondary	-0.10	1.00																		
Household head has completed post-secondary technical	-0.07	-0.02	1.00																	
Household head has completed university and higher	-0.04	-0.01	-0.01	1.00																
Household head has completed formal adult education/litarcy program	-0.13	-0.04	-0.03	-0.02	1.00															
Household head has bank account	0.19	0.12	0.15	0.09	-0.01	1.00														
Western	0.11	0.02	0.00	0.01	-0.02	0.08	1.00													
Central	0.11	-0.03	0.00	0.00	-0.06	-0.02	-0.10	1.00												
Greater Accra	0.00	0.03	0.01	0.03	-0.02	0.04	-0.04	-0.04	1.00											
Volta	0.05	0.03	0.03	0.00	0.02	0.00	-0.11	-0.10	-0.04	1.00										
Eastern	0.11	0.01	0.03	-0.01	-0.04	0.02	-0.11	-0.11	-0.04	-0.12	1.00									
Ashanti	0.10	0.00	0.01	0.02	-0.03	0.09	-0.09	-0.09	-0.04	-0.10	-0.10	1.00								
Brong Ahafo	0.06	0.01	-0.01	0.00	0.00	0.12	-0.12	-0.11	-0.04	-0.12	-0.13	-0.11	1.00							
Northern	-0.17	0.00	-0.03	-0.01	0.04	-0.12	-0.14	-0.13	-0.05	-0.14	-0.15	-0.12	-0.15	1.00						
Upper East	-0.15	-0.03	-0.01	-0.01	0.04	-0.10	-0.12	-0.11	-0.04	-0.12	-0.13	-0.10	-0.13	-0.15	1.00					
Upper West	-0.14	-0.02	-0.02	0.00	0.03	-0.06	-0.12	-0.12	-0.05	-0.13	-0.14	-0.11	-0.14	-0.16	-0.14	1.00				
Rural area	-0.06	-0.05	-0.06	-0.07	0.06	-0.11	0.00	-0.05	-0.06	0.02	-0.03	-0.03	-0.09	0.02	0.04	0.13	1.00			
Urban area	0.06	0.05	0.06	0.07	-0.06	0.11	0.00	0.05	0.06	-0.02	0.03	0.03	0.09	-0.02	-0.04	-0.13	-1.00	1.00		
Time taken to reach the closest health facility	0.00	0.00	0.03	-0.01	0.03	0.02	0.03	-0.02	0.00	0.02	0.02	0.02	-0.03	-0.02	0.02	-0.04	0.00	0.00	1.00	

Annex 2: Model without robust standard errors (heteroscedasticity test)

Variables	Off-farm Participation	Vulnerability	
		Off-farm Participant % Food expenditure	Off-farm Non-Participant % Food expenditure
Farm profit (GHS)	-0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)
Log expenditure on market foods (GHS)	0.2462*** (0.0251)	7.9561*** (0.6432)	3.0468*** (0.2038)
Log expenditure on utility (GHS)	0.0135*** (0.0039)	-0.2648*** (0.0698)	-0.2096*** (0.0511)
Log expenditure on Housing (GHS)	0.0053 (0.0038)	-0.6936*** (0.0701)	-0.6726*** (0.0472)
Log expenditure on healthcare (GHS)	0.0065* (0.0034)	-0.3251*** (0.0606)	-0.3026*** (0.0429)
Log expenditure on education (GHS)	0.0259*** (0.0037)	-0.6560*** (0.0899)	-0.5980*** (0.0464)
Household head has not completed Pre-school/ primary	0.2012*** (0.0493)	-0.8655 (0.9329)	-2.8253*** (0.6275)
Household head has completed primary	0.0854 (0.0529)	-1.8298* (0.9676)	-2.5574*** (0.6448)
Household head has completed lower secondary	0.2408*** (0.0455)	-1.8229** (0.9175)	-5.4301*** (0.5883)
Household head has completed upper secondary	0.0789 (0.0871)	-4.3557*** (1.4501)	-5.8259*** (1.1498)
Household head has completed post-secondary technical	-0.1009 (0.1216)	-7.8120*** (2.0297)	-10.4627*** (1.6173)
Household head has completed university and higher	-0.2468 (0.1984)	-16.7167*** (3.4492)	-16.9834*** (2.5362)
Household head has completed formal adult education/literacy	0.2370***	0.8683	-1.2709

	(0.0664)	(1.1745)	(0.8975)
Size of Household	0.0448*** (0.0064)	-0.3733*** (0.1333)	-0.4051*** (0.0888)
Male-headed household	0.2262*** (0.0416)	-2.5337*** (0.8932)	-2.1965*** (0.4969)
Size of livestock owned	-0.0001 (0.0005)	-0.0525*** (0.0174)	-0.0083* (0.0046)
Size of agricultural land own	-0.0022 (0.0031)	-0.1427 (0.1089)	-0.0114 (0.0308)
Size of poultry own	0.0006* (0.0003)	-0.0136*** (0.0023)	-0.0002 (0.0075)
Household head has bank account	0.2118*** (0.0371)	-2.6398*** (0.7084)	-5.0654*** (0.5227)
Log annual remittance recieved (GHS)	0.0133*** (0.0029)	0.0004 (0.0558)	-0.1757*** (0.0384)
Western region	0.3095** (0.1332)	-2.8714 (2.3429)	1.9064 (1.6809)
Central region	-0.2308* (0.1361)	2.2134 (2.4521)	4.6000*** (1.6581)
Volta region	0.3723*** (0.1326)	4.5639* (2.3719)	4.3373*** (1.6658)
Eastern region	0.3343** (0.1325)	0.7529 (2.3497)	2.3946 (1.6606)
Ashanti region	0.2055 (0.1354)	2.2576 (2.3491)	4.1669** (1.6980)
Brong Ahafo region	0.0686 (0.1332)	-0.5331 (2.3124)	5.2390*** (1.6419)
Northern region	0.1851 (0.1322)	7.7781*** (2.3152)	5.3797*** (1.6382)
Upper East region	-0.0365 (0.1351)	3.7825 (2.3875)	4.9350*** (1.6447)
Upper West region	0.6983*** (0.1341)	1.9458 (2.6531)	-2.7816* (1.6830)
Urban area	0.0899** (0.0433)	-5.1451*** (0.7337)	-3.4055*** (0.5665)
Time taken to reach the closest health facility	-0.0397** (0.0195)		
Constant	-4.8979*** (0.3380)	-32.2920** (13.1496)	33.5060*** (2.9750)
Observations	8,439	8,439	8,439
	/lns1=2.5731***	/lns2=2.6961***	/r1=0.2795
	rho_1=0.2724717	rho_2= -.5266455	/r2=-0.5855***
	Standard errors in parentheses		
	*** p<0.01, ** p<0.05, * p<0.1		

Annex 3: Falsification test (Instrumental variable test)

Variables	OLS	Probit
	Vulnerability to food insecurity	Off-farm participation
Farm profit (GHS)	2.77e-07* (1.55e-07)	0.00819** (0.00391)
Log expenditure on market foods (GHS)	3.306*** (0.510)	-2.08e-08** (8.87e-09)
Log expenditure on utility (GHS)	-0.148*** (0.0504)	0.0923* (0.0531)
Log expenditure on education (GHS)	-0.506*** (0.0448)	0.253*** (0.0452)
Long expenditure on healthcare (GHS)	-0.270*** (0.0444)	0.0949 (0.0875)
Log expenditure on Housing (GHS)	-0.641*** (0.0479)	-0.0711 (0.123)
Household head has not completed Pre-school/primary	-2.181*** (0.588)	-0.224 (0.206)
Household head has completed primary	-2.286*** (0.616)	0.259*** (0.0679)
Household head has completed lower secondary	-4.514*** (0.558)	0.0523*** (0.00654)
Household head has completed upper secondary	-5.463*** (1.182)	0.226*** (0.0423)
Household head has completed post-secondary technical	-10.76*** (1.683)	-3.81e-05 (0.000291)
Household head has completed university and higher	-17.78*** (2.539)	-0.000817 (0.00278)
Household head has completed formal adult education/literacy	-0.248 (0.933)	0.000579** (0.000229)
Size of Household	-0.175** (0.0872)	0.0147*** (0.00391)
Male-headed household	-1.486*** (0.465)	0.110** (0.0430)
Size of livestock owned	-0.00858*** (0.00179)	0.202*** (0.0494)

Size of agricultural land own	-0.0128 (0.0234)	0.0282*** (0.00382)
Size of poultry own	0.00313 (0.00822)	0.00852** (0.00345)
Household head has a bank account	-4.091*** (0.510)	0.628*** (0.134)
Log annual remittance recieved (GHS)	-0.133*** (0.0364)	0.148*** (0.0226)
Western region	2.999* (1.590)	0.228*** (0.0376)
Central region	3.676** (1.547)	0.0125*** (0.00298)
Volta region	5.442*** (1.577)	0.304** (0.133)
Eastern region	3.433** (1.551)	-0.275** (0.136)
Ashanti region	4.647*** (1.586)	0.335** (0.133)
Brong Ahafo region	5.151*** (1.584)	0.313** (0.133)
Northern region	5.752*** (1.547)	0.170 (0.135)
Upper East region	4.620*** (1.529)	0.0219 (0.134)
Upper West region	-0.724 (1.608)	0.143 (0.133)
Urban area	-2.906*** (0.532)	-0.0869 (0.135)
Time taken to reach the closest health facility	-0.0494 (0.154)	-0.0335* (0.0188)
Constant	29.59*** (6.414)	-3.698*** (0.313)
Observations	5,887	8,439
R-squared	0.220	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Annex 4: ATT result ESR model without instruments

Sample	Decision Stage		
	To participate	Not to participate	Effects
	20(a)	20(d)	ATT
Farm household who participated in off-farm	54.69*** 0.17	60.07*** 0.10	-5.37*** 0.19
	20c	20(b)	ATU
Farm household who did not participate in farm	52.57*** 0.14	44.06*** 0.12	8.51*** 0.23
	HT1	HT2	TRH
Heterogeneity effect	10.64*** 0.21	7.50*** 0.17	3.14***

