Participants in Non-Farm Activities in Rural Sudan: Patterns and Determinants

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Participants in Non-Farm Activities in Rural Sudan: Patterns and Determinants

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Abstract

Despite the importance of non-farm income in the livelihood of the rural population in Sudan, information available on its size and determinants is scanty. This study examined the patterns and determinants of decisions to participate in non-farm activities in rural Sudan. It also investigates whether the determinants of participation in non-farm activities vary across agriculture sub-sectors and income groups as well as among males and females. The data for this study was sourced from the Sudanese National Baseline Household Survey (NBHS) conducted by Sudan's Central Bureau of Statistics in 2009. The results show that non-farm income is a crucial source of livelihood, contributing about 43% to household income in rural Sudan. The results of multinomial logit and probit estimation methods indicate that educational level, mean of transportation, lack of land and lack of access to formal credit are the most significant factors that push rural farmers to participate in non-farm activities. Surprisingly, the effect of household income was positive and significant, implying that individuals from rich households have higher opportunity to engage in non-farm activities compared to their poor counterparts. Moreover, the analysis revealed some symptoms of gender and location disparities in the effect of factors that influence participation in non-farm activities. The study concluded with some recommendations that aim to enhance the engagement in non-farm activities as an important diversification strategy to complement the role of the agriculture sector in improving rural economy in Sudan.

Key words: Income diversification, non-farm income, labour force participation, Sudan

JEL Classification: Q12, L25,

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1. Introduction

In the presence of unfavourable economic conditions, most of the rural population in developing countries tend to obtain their livelihoods from diverse sources of income and are not entirely dependent on agriculture. Indeed, a considerable portion of rural households in poor countries are involved in non-farm activities such as trading and rural manufacturing. A large body of empirical studies has shown that non-farm activities represent an important source of livelihood for small-scale farmers, and contribute between 20% and 60% to the total household income in rural areas (Newman and Gertler, 1994; Reardon, 1997; Ellis, 1998; Lanjouw and Lanjouw, 2001; Adams, 2001 and Kimhi, 2004;).

Like other developing countries, agriculture in Sudan is a dominant sector and contributes on average about 40% to the total gross domestic product (GDP) and employs about 75% of the total population. The agriculture sector also ensures the livelihood of about 70% of the total population, most of them living in rural areas (World Bank, 2014). However, the role of farming in generating rural income has declined remarkably in recent decades, owing to the breakdown of the agriculture sector. Agriculture in Sudan has deteriorated significantly in the past two decades due to government policies, such as the adoption of structural adjustment programmes, which were launched in the early 1990s. Moreover, the exploitation of oil at the end of 1990s diverted the government's attention from agriculture to the oil industry. These factors have weakened agricultural production; hence a large portion of rural farmers has been pushed to non-farm activities to supplement their meagre agricultural income or to smooth intra-seasonal cash flows and consumption. However, despite the significant role of non-farm activities in the rural economy, many small-scale farmers have not been able to diversify their income sources by engaging in non-farm, income-generating activities. Therefore, this study aimed to investigate the factors that encourage small-scale farmer to participate in non-farm activities and diversify their income sources.

Against this backdrop, the main questions of this study were: What are the determinants of participation in non-farm activities? What are the contributions of non-farm activities to the total rural income and employment? To what extent could the determinants of participation in non-farm activities vary across different agriculture sub-sectors and among male and female farmers?

Regarding the importance and policy relevance, the analysis undertaken by this

study was decisive for several reasons. First, despite the importance of rural non-farm activities in a typical developing country like Sudan, the information available on its size, determinants, and the various roles it can play in economic development is meagre; and there are no empirical studies examining the factors that influence the participation in non-farm activities and income diversification in rural Sudan. Therefore, the empirical results emerging from this study would guide appropriate policies to enhance income generating activities in rural Sudan. Second, gender disparities in the factors affecting participation in non-farm activities cannot be ignored. This is because the participation of females and males may be affected differently because of gender specific inequality in education and labour markets and in the prevailing norms about the role of females and males in society. Thus, apart from investigating the determinants of participation for the full sample, the study also examined the gender-differentiated effects of the factors that influence participation in non-farm activities. This would be crucial in designing an effective strategy that may empower women and reduce gender inequality in rural Sudan. Third, the agriculture sector in Sudan is classified into two sub-sectors in terms of irrigation: the irrigated and the rainfed sub-sector. The two sectors are different in terms of location characteristics, types of crops and inputs used in farming activities. Therefore, the factors that influence household member participation in farm and non-farm activities may vary across these sub-sectors. Thus, this study examined the determinants of participation in non-farm activities in both irrigated and rainfed systems. This could be helpful in designing appropriate pro-poor policies to allocate infrastructure and services across irrigated and rainfed areas.

The remainder of this study is organized as follows. Section two outlines the labour market in rural Sudan and the patterns of non-farm activities. Section three reviews the empirical literature, and section four outlines the conceptual framework and research methodology. Section five presents the empirical results. Section six presents the conclusion and policy implications.

2. Labour market and the patterns of non-farm activities in rural Sudan

Due to economic vulnerability, inequality and declining agricultural productivity in the past decades, the rural labour market in Sudan has expanded remarkably. Some previous studies (e.g., El Mangouri, 1990; Mohamed, 1986) affirmed that during the 1970s and 1980s, the rural labour market was very small and the wage rate did not reflect the marginal productivity of labour. Their justifications were based on the argument that land is available in rural areas and major farming operations such as ridging and weeding were synchronized. However, other studies contradict this view (e.g., Babiker and Ahmed, 1988; Kevane, 1994; Babikir and Babiker, 2007), arguing that the labour market exists in rural Sudan. Because of unequal distribution of land among rural households a sizable segment of the population practises wage employment in both the farm and the non-farm sectors. Likewise, agricultural operations are not fully synchronic, but may vary depending on the type of crop, hence many farmers may engage in non-farm activities during off-season production. Kevane (1994) found evidence of an active labour market in rural areas of western Sudan. He argued that supply and demand of labour affect wage rates and patterns of employment. Babiker and Ahmed (1988) also confirmed the existence of a labour market in the Blue Nile agricultural schemes, which mainly lie in the rural areas. Moreover, Babikir and Babiker (2007) showed evidence of high rates of rural labour market participation in irrigated agriculture, particularly the Gezira scheme.

The labour market in rural Sudan is classified into two types of work: non-farm and on-farm activities. Non-farm activities include work such as non-farm self-employment and non-farm wage employment. On-farm work includes the work performed by farmers in their own farms. The labour supply in rural areas is sourced from family labour and migrants, who include casual and regular workers (Babiker and Ahmed, 1988). However, the demand for labour is mainly derived from wealthier farmers who own large farms and have capital assets. The other part of labour demand comes from service activities like construction and trade. Moreover, labour in rural Sudan is characterized by low productivity and wages like in other developing countries. There is also seasonality in labour demand and supply due to the nature of activities in rural areas. In addition, participation of females in the rural labour market is remarkable and varies across states and ethnic groups. For example, in western states the share of females in the labour market is high, while in eastern states their participation is low due to some customs and traditions that prohibit female labour.

The primary non-farm activities in rural areas are classified into three categories: wage employment in private organizations, wage employment in the public sector and non-farm self-employment. Wage employment in private and public organizations includes professional wage work (e.g., driver), skilled labourer (e.g., mechanics) and unskilled wage work. The employers of this labour type could be small and/or large such as non-governmental organizations (NGOs), government organizations, urban dwellers and contractors. The non-farm labour is concentrated in the services sector like construction, transportation, health, education and retail trade. Non-farm self-employment includes handicrafts, milling, weaving, agro-processing, trade in grain and livestock, collecting and selling firewood, and selling local food.

3. Literature review

Considering the importance of non-farm income in the livelihood of rural households, the issue of non-farm activities has received great attention from both policy makers and researchers in developing countries. However, what causes or determines participation in non-farm activities has not been as extensively examined in either the Sudan, or in sub-Saharan Africa, and studies have not differentiated between rainfed and irrigated farming.

The literature indicates several factors that influence farmer participation in non-farm activities; among them are individual characteristics, household characteristics and farm characteristics, and the risks of farming. For example, Abdulai and Delgado (1999) examined factors contributing to non-farm activities in northern Ghana, using a bivariate probit model. They found that an increase in age raises the probability of labour supply to engage in the non-farm sector. They also found that education and working experience are significant variables that stimulate non-farm earnings and allow rural families to diversify their income away from agriculture. Moreover, their results indicated that infrastructure and population density have positive and significant effects on the probability of doing non-farm work. However, non-labour income and distance to capital cities negatively affect participation in non-farm work for both males and females.

Abdulai and CroleRees (2001) studied the determinants of income diversification in southern Mali, using household level panel data from a representative sample of rural households. They found that poorer households have fewer opportunities to engage in non-farm activities such as livestock rearing, and hence have less diversified incomes. Their results also indicate that households in remote areas are less likely to participate in non-farm activities than are their counterparts who reside closer to local markets. Moreover, households with educated heads are more likely to participate in the non-farm sector than those with illiterate heads.

De Janvry and Sadoulet (2001) investigated the factors that affect access to non-farm activities in rural Mexico, adopting a multinomial estimation method. They classified non-farm activities into five categories: wage labour, construction work, non-agricultural wage labour, self-employment in non-agricultural work, and seasonal migration to the United States. Their results revealed that individual age, marriage, education, ethnic origin and regional availability of non-farm employment are the most important factors affecting participation in non-farm activities. In particular,

the level of education is a significant factor for both males and females to engage in non-farm activities.

In the same vein, Escobal (2001) examined the determinants of non-farm income diversification in the rural Peru. He pointed out that location and ownership of assets are the most important determinants of income diversification in rural Peru. He also found that access to credit is a key determinant of self-employment in both the farm and the non-farm sectors. This implies that non-farm income relaxes the cash constraint as a substitute for credit. Moreover, Escobal (2001) found that education is a significant factor affecting income diversification, arguing that a high level of education reduces the incentive to obtain income from farming activities. Other variables like roads, access to public assets and rural electrification are found to be significant factors that enhance income diversification.

Likewise, Beyene (2008) investigated factors that encourage farm households to participate in non-farm work in rural Ethiopia. Using a bivariate probit model, he found that health and training have a positive impact on participation in non-farm activities. As most non-farm activities do not require formal education, education of the head of household has no significant impact on the participation decision. The author also pointed out that availability of credit and income from non-farm activities positively affects the decision of males to participate in such activities. Socioeconomic and farm characteristics are among the most important factors affecting participation in non-farm work.

Atamanov and Van den Berg (2011) examined the factors that influence participation in non-farm activities in Kyrgyz during 2005–2006. He found that non-farm activities are the most important source of income for poor households. Following the models of Barret and Reardon (2000)) and Reardon et al (2001), Atamanov and Van den Berg (2011) divided the explanatory variables into five groups: individual characteristics, household characteristics, household assets, location characteristics and access to public utilities. Using the double hurdle model, the study revealed that residing in remote areas, lack of capital, education and access to infrastructure are the most significant factors influencing participation in non-farm activities.

Regarding the case of Sudan, there is a dearth of studies on the issue of non-farm income. However, some empirical studies on the rural economy argued that non-farm income plays a significant role in assuring the fundamental requirements of rural households in Sudan (Ibnouf, 2009). For example, Ibnouf (2009) found that rural non-farm activities in western Sudan have a substantial positive impact on improvement and sustainability of household food security and contribute with about 40% to total rural income.

From this discussion, it is clear that the literature on factors that influence participation decision in non-farm activities is extensive and diverse. However, there is a dearth of studies on such issues in sub-Saharan African countries in general and Sudan, in particular. Thus, this study aimed to fill the gap in literature on the patterns and determinants of participation in non-farm activities. Furthermore, the available literature does not consider the types of agriculture in terms of irrigation, like irrigated

and rainfed sectors. Notably, farming characteristics such as land tenure, production relationships, and cultivation times vary across the agriculture sub-sectors. The significant contribution of this study is to investigate the determinants of non-farm work participation decisions of rural farmers, focusing on each sector separately.[1]

4. Conceptual framework and research methodology

Conceptual framework

The theoretical framework adopted in this study follows the farm income model developed by Huffman (1980, 1991) and Benjamin (1992). The labour supply decision of the farmer is derived from a behavioural model that permits both farm and non-farm work (Huffman, 1991). This model suggests that farmers allocate their time between farm employment, non-farm employment, and leisure by maximizing their utility function (U) from consumption of goods (Q), leisure (H) and other exogenous factors(E). The function that conveys information on his utility maximizing behaviour can be expressed as:

$$MaxU = U(Q, H, E) \quad (1)$$

Utility is maximized subject to three constraints: time, budget and production characteristics constraints. First, the time constraint is as follows:

$$T = L_1 + L_2 + H \quad (2)$$

Hence $H = T - L_1 - L_2$

T represents the total time endowment, which is assumed to be allocated between farm activities (L_1), non-farm activities (L_2) and leisure time (H).

Second, the budget constraint on farmer cash income can be specified as follows:

$$PQ = w_1 L_1 + w_2 L_2 + R \quad (3)$$

Assuming that input and output markets exist and are competitive, P is the prevailing price of consumption commodities purchased, Q is the consumption commodity, w_1 and w_2 represent returns to own-labour used in own-farm work and non-farm work respectively, and R denotes the non-labour income (other household income). The budget constraint shows that the farmer's total consumption is equal to his total income, which is supposed to be generated from farm and non-farm activities plus income from other miscellaneous sources.

Finally, to elaborate the production constraint, we assume that the production and consumption decisions are separable. Let the own-farm production function be:

$$Y = Y(L_1, E) \tag{4}$$

Where Y is own-farm output, L_1 is as defined earlier, and E is exogenous factors that influence farm production. Furthermore, let the competitive price of output be P, and corresponding linear production cost function be $C = w_1 l_1$, where w_1 is the opportunity cost of labour. In addition, assume that the returns to own-labour used on own-farm is higher than the returns to non-farm activities (i.e., $w_1 > w_2$). Thus, the profit maximization labour usage on own farm is:

$$L_1^* = L_1(w_1, P; E) \tag{5}$$

Equation 5 implies that farming output is a function of returns to labour from farm work (w_1), market prices (P) and some exogenous factors (E) such as the characteristics of individuals and households.

Substituting Equation 5 in (2) and (3), the utility maximization problem can be specified in the following Lagrangian function:

$$l = U(Q, T - L_1(w_1, P; E) - L_2), E) + \lambda[PQ - w_1 L_1(w_1, P; E) - w_2 L_2 - R] \tag{6}$$

Taking the first order conditions:

$$\frac{\partial l}{\partial L_2} = U_{l2} - \lambda w_2 \ = 0 \tag{7}$$

$$\frac{\partial l}{\partial Q} = U_Q + \lambda P = 0 \tag{8}$$

$$L_{2i} = L_2(w_1, w_2, P, E, R) \tag{9}$$

By solving the first order conditions simultaneously, the labour supply functions for non-farm work can be derived as follows:

$$L_{2i} = L_2(E, R) \tag{10}$$

Based on the assumption of a competitive market, the output price and wages are given and constant. Therefore, the decision embarked by individual to perform a non-farm work is determined by exogenous factors (E) and non-labour income (R). This relation can be expressed by the following function:

$$par_i = \beta_1 + \beta_2 X_i + \beta_3 HC_i + \beta_4 A_i + \beta_5 INF_i + \mu_i \tag{11}$$

Accordingly, the factors adopted in the empirical analysis to explain individuals' participation decision in non-farm activities can be grouped into a set of explanatory variables, which includes: individual characteristics, household characteristics and location characteristics, and non-labour income.

Model specifications and data

To examine the determinants of the decision by rural farmers to participate in non-farm activities, the study used econometric methodology. Following Corral and Reardon (2001) and Yúnez-Naude and Taylor (2001), we classified non-farm activities into two major groups, namely non-farm wage work and non-farm self-employment. This categorization is due to the availability of data and because it reflects the nature of non-farm activities in rural Sudan. To identify the determinants of non-farm participation decision and participation in specific non-farm activity, the study estimated two regression models: the first one is for labour supply participation in farm and non-farm work, and the second model is delegated to explore the determinants of participation decision in specific non-farm activity (i.e., wage work and self-employment). The dependent variables in both models are binary variables, which are functions of

individual characteristics, household characteristics, household assets and location characteristics.

In the first model, the dependent variable is the participation in three distinct sets of activities, namely farm activities, non-farm activities, and a combination of farm and non-farm activities. Thus, the estimable regression model of participation decision in labour market could be specified as follow:

$$g_i = \delta_1 + \delta_2 X_i + \delta_3 HC_i + \delta_4 A_i + \delta_5 INF_i + \varepsilon_i \quad (12)$$

The second model estimates the determinants of individual participation in the specific non-farm activities namely, wage work and self-employment. Thus, the estimable regression model for the determinants of non-farm participation decision in specific non-farm activities is specified as follows:

$$g_i = \delta_1 + \delta_2 X_i + \delta_3 HC_i + \delta_4 A_i + \delta_5 INF_i + \varepsilon_i \quad (13)$$

The dependent variable (par) in Equation 11 represents the participation in labour market, while the dependent variable (g) in Equation 12 reflects the participation in specific non-farm activities. Equation 11 and Equation 12 are explained by identical explanatory variables, derived from the theoretical framework described previously and could be grouped into individual characteristics (X), household characteristics (HC), household assets (A), location characteristics and access to infrastructure (INF). Specifically, the individual characteristics include age, square of age, education, gender and marital status. The household characteristics include the demographic structure of the household, such as size of the household, number of dependents in household and the household income. Household assets can be land or mobile assets like motorcycles and cars. Finally, the location characteristics and infrastructure include factors such as, distance to nearest urban centre, access to public services like electricity, and access to formal credit. The definition and descriptive statistics of the variables used in the analysis are presented in Section 5.

The data for this study were gathered from the National Baseline Household Survey (2009) conducted by Sudan's Central Bureau of Statistics. The survey covered information about individuals and household characteristics, expenditure items, sources of income, and labour status in urban and rural Sudan. This study used only the rural population sample, comprising 5,454 households with 33,616 individuals. Specifically, the analysis focused on 7,238 individuals, who were active workers of age 14 years and above. The 15 states covered by the survey were divided into two sub-samples: irrigated and rainfed agricultural states, so as to examine the variation in the determinants of participation in non-farm activities across different agricultural sub-sectors. The irrigated areas include six states while the rainfed agriculture involves nine states.

Estimation methodology

To estimate the two models with two different dependent variables, we used different estimation techniques. The dependent variable in the first model reflects the question of which factors affect the choice between doing farm, non-farm or a mixture of both activities. Since there were more than two choices, we used the multinomial logit (MNL) regression to estimate the first model. As the analysis in this stage aimed at explaining the variables that determine the choice between farm and non-farm activities, the farm category was chosen as reference one.

Using multinomial logit requires fulfilling the assumption of the independence of irrelevant alternatives (IIA). IIA implies that choices made are assumed to be independent of the remaining alternatives. Therefore, the selection of probabilities would be changed in the same proportion when a new outcome is introduced or a deletion of an existing outcome is made. This suggests a test of whether the coefficients of the choice model are constant when there are changes in the set of alternative outcomes. A violation of assumption of the IIA results in an inappropriate multinomial logit model. Following the existing literature on multinomial logit, we tested the independence of irrelevant alternative using the Hausman-McFadden (1984) test and the Small-Hsiao (1985) test. To examine whether the outcomes are distinguishable, we carried out the Wald test to combine the dependent occupational categories.

The second model reflects the determinants of participation in specific non-farm activity. The hypothesis here postulates that there is a difference in the factors that influence the specific type of non-farm activities. Since we were not interested in comparing the results of one particular group to another as in the first model, we used the probit regression technique to estimate the equation of participation in the two primary non-farm activities (i.e., wage work and self-employment). In literature, both multinomial logit and probit have been widely used to investigate participation in rural non-farm activities (e.g., Corral and Reardon, 2001; De Janvry and Sadoulet, 2001; Lanjouw and Shariff, 2004).

The above estimation procedures (i.e., multinomial logit and probit models) were implemented for both aggregate and sub-sectoral agricultural levels to examine whether the determinants of participation in non-farm activities vary across different agricultural sub-sectors. The participation model was also fitted for both males and females, to examine the gender disparity in the factors that influence participation in non-farm activities. Finally, we examined the factors that affect non-farm participation across different income quintiles using the probit estimation technique.[2]

Explanatory variables and possible endogeneity

From an empirical perspective there has been much discussion in the literature regarding the potential endogeneity associated with some explanatory variables such as household income and assets variables. The possible endogeneity of household income and assets like owning motorcycles could be raised because these are essential

variables that reflect household welfare, hence they are expected to affect individual decisions regarding participation in non-farm activities. Thus, explicit inclusion of household income and owning a motorcycle may be endogenous to participation decision, primarily because individuals participating in non-farm activities may contribute to household income and assets. To test the endogeneity of such variables we used Smith and Blundell (1986) two-step procedure as suggested by Wooldridge (2010). The household income was regressed on the same set of explanatory variables as in the multinomial logistic MNL regression model with additional identifying regressors that are considered to determine income but not non-farm participation decisions.[3] The estimated coefficient of the residuals obtained from the income equation was statistically significant in the all models, suggesting the endogeneity of income. Therefore, to overcome this problem the study used expenditure per capita as a proxy for household income. Again the Smith and Blundell (1986) test was implemented and the result revealed the exogeneity of expenditure. Hence, the expenditure per capita was used instead of income in the models under consideration. Regarding the motorcycle variable, the Smith and Blundell (1986) test was also executed and the results indicated that owning a motorcycle is exogenous.

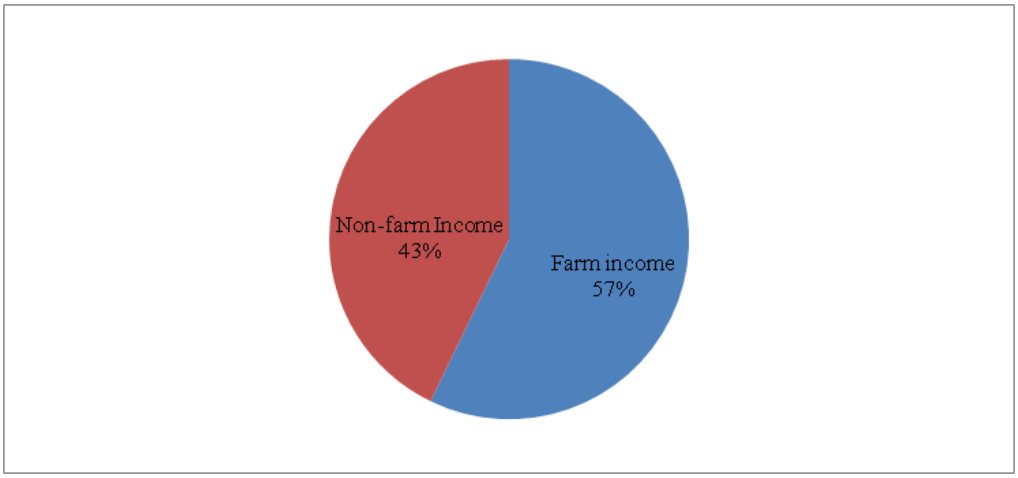
5. Empirical results and discussion

In this section we present the empirical results and discussion. First, we present some patterns of non-farm activities in rural Sudan, and then report the empirical results.

Patterns of non-farm activities in Sudan

Before analysing the factors that influence participation in non-farm activities, it is crucial to understand the patterns of non-farm activities and the sources of income in rural Sudan. Figure 1 shows the sources of income in rural areas and that the source of income is divided into farm and non-farm income.

Figure 1: Sources of income in rural Sudan



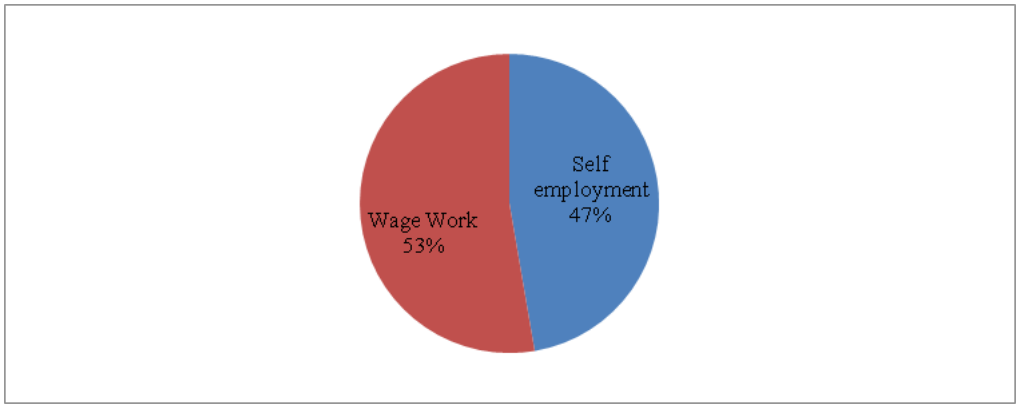
Source: Author' own calculation based on NBHS (2009)

Figure 1 indicates that non-farm income represents about 43% of the total income received by households in rural Sudan. This implies that non-farm income is an important source of livelihood in rural areas. This also confirms the situation in most

developing and African countries, as non-farm income plays a considerable role in rural livelihood (see Reardon, 1997). Specifically, Reardon (1997) argued that in Africa the share of incomes earned from the non-farm sector is about 45%. In the same report, the author showed that for the case of Sudan the contribution of non-farm income to total household income was 38% in 1988. Thus, our results imply that the non-farm sector in rural Sudan has enlarged during the recent decades.

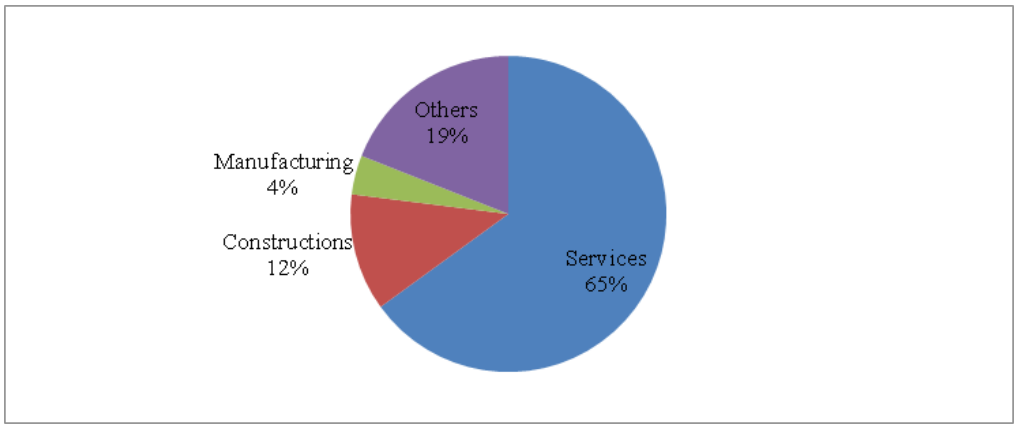
Regarding the contribution of specific sources of non-farm income to total non-farm income in rural Sudan, Figure 2 reports the breakdown of non-farm income into the main sources of self-employment and wage employment. As shown in Figure 2, wage work is the largest source of non-farm income in rural Sudan, contributing about 53%; followed by self-employment contributing 47%. The larger share of wage work indicates that most individuals in rural areas probably lack appropriate assets and credit to engage in self-employment activities.

Figure 2: Breakdown of non-farm income by non-farm activities



Source: Author's own calculation based on NBHS (2009)

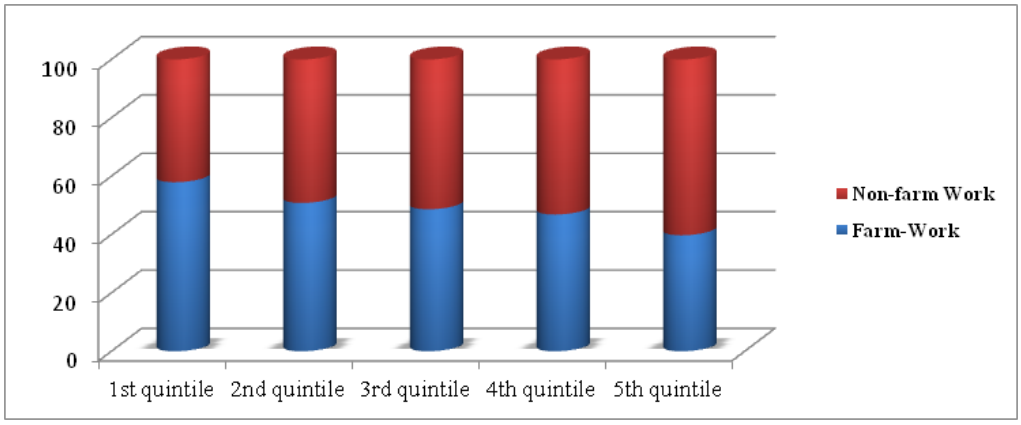
In accordance with the types of non-farm activities, Figure 3 classifies the self-employment and wage work activities into four main types, including manufacturing, construction, services and others. As indicated in Figure 3, service activities employ the largest segment of the population (65%). However, a small portion of the population engages in construction and manufacturing activities, about 12% and 4% respectively. The high share of service activities in rural income reflects the actual situation in Sudan, as the service sector occupies the lion's share of the country's GDP. In addition, the low rate of manufacturing also reflects the disappointing performance of the manufacturing sector in the country.



Source: Author' own calculation based on NBHS (2009)

In accordance with the distribution of non-farm participation by income status, Figure 4 presents the participation in farm and non-farm activities by income quintiles. Most of the lowest income quintile engages in farm activities (Figure 4). However, most individuals belonging to the richest income quintile were participating in non-farm activities. In general, participation in non-farm activities increase as household income increases (Figure 4). This also suggests that poorer households have fewer opportunities to diversify their income, as non-farm activities need capital and assets which are not available for poor income groups. Hence, rich households have better access to non-farm income. This finding also suggests that poor individuals obtain most of their income from farm activities and has lower probability to diversify their income.

Figure 4: Participation in farm and non-farm activities by income quintile (percentage)



Source: Author's own calculations based on NBHS (2009)

Regarding the description of explanatory variables, Table 1 presents the descriptive statistics of the variables used in the analysis. The average individual age is about 35 years which is consistent with the national average, implying that rural areas suffer

from the problem of high youth unemployment, as most of the people engage in work in old age (Table 1). The average education level is relatively low with high disparity as indicated by the standard deviation, confirming the low rate of school enrolment among the rural population. Table 1 also shows that about 83% of households are headed by males. The average household size is about six members, which is consistent with the national average reported by NBHS (2009). The average dependency ratio is relatively high, implying that the number of children in households is higher than the number of adults, on average, suggesting household exposure to poverty. In addition, the reported statistics indicate that the standard deviations of per capita expenditure and total income are very high, implying a high rate of income inequality in rural Sudan. This result is consistent with the fact that most rural areas in Sudan exhibit a high rate of income inequality, as indicated by NBHS (2009). Moreover, the average non-farm income is high compared to farm income, confirming the importance of non-farm income in maintaining the livelihoods of rural households. The low mean of access to electricity and credit variables indicate that a small portion of households has access to electricity and formal farm credit. The total household income of 426 Sudanese pound (SDG) per month, is somewhat lower than the national average in 2009, but consistent with the actual situation in rural areas.

Table 1: Descriptive statistics of the variables used in the analysis

Variable	Definition	Mean	Std. Dev.
Age	Age of individual in years	35.589	15.478
Male	Dummy (1 = male; 0 = female)	0.788	0.409
Education	Number of years of schooling of individual	3.885	4.065
Married	Dummy (1 = married; 0 = unmarried)	0.654	0.476
Household size	Number of household members	6.956	3.090
Dependency ratio	Number of population aged zero to 14 and over the age of 65, to the total population, aged 15 to 64	0.933	0.893
Land	Dummy variable (1 = own land; 0 = otherwise)	0.708	0.455
Expenditure	Expenditure per capita in SDG	131.024	94.602
Farm income	Total household farm income in SDG	133.470	506.817
Non-farm income	Total household non-farm income in SDG	293.187	817.111
Total income	Total household income in SDG	426.658	958.380
Own a motor cycle, dummy	Dummy variable, (1 = own motor cycle; 0 = otherwise)	0.019	0.137
Access to farm credit, dummy	Dummy variable (1 = access to credit; 0 = otherwise)	0.565	0.496
Distance to urban centre (minutes)	Distance in minutes	25.876	39.913
Access to electricity, dummy	Dummy variable (1 = access to electricity; 0 = otherwise)	0.242	0.429

Determinants of participation in non-farm activities: Econometric analysis

In this sub-section we report the estimation results of Equation 11 and Equation 12 using the multinomial logit and probit estimation techniques respectively. As stated previously in the methodology section, the study estimated two models: the first model concerning the labour supply participation in farm and non-farm activities, and the second for the determinants of participation in specific non-farm activities. These models were estimated for three specifications: full sample, irrigated, and rainfed samples. In addition, to investigate whether the determinants of participation vary among males and females and across income quintiles, the second model was estimated using a probit technique for both a male and a female sample, and for different income quintiles.

Determinants of participation in non-farm activities: A multinomial logit model

The estimation results of the multinomial logit model for the full sample (all inclusive) are presented in Table 2. Since there were three choices of participation: farm, non-farm, mixture of farm and non-farm activities, we used farm activities as the base category.

The table shows that all the explanatory variables carried their expected signs, except household size and per capita expenditure. Table 2 also indicates that most of the coefficients were statistically significant. The results of the IIA test using the Hausman-McFadden and the Small-Hsiao tests are presented in Appendix A. Both tests accept the null hypothesis indicating that the multinomial logit specifications are appropriate for the analysis. In addition, the results of the Wald test reject the null hypothesis that the variables used do not differ across categories. Therefore, we cannot combine any occupational category.

Age, education, dependency ratio, expenditure per capita, and owning a motorcycle, had positive and significant effects on participation in both non-farm and mixed activities (Table 2). However, square of age, owning land, access to farm credit, and distance to urban centres had a negative and significant effect on access to non-farm activities. Specifically, the coefficient of age was positive and significant, indicating that an increase in individual age increased the probability of engagement in both non-farm and mixed activities. It indicates that older people probably have assets and experience to facilitate their participation. The effect of age squared was negative and statistically significant in both models, indicating a non-linear relationship between age and participation in non-farm activities. This implies that the probability of participating in non-farm activities increases with age, but at a decreasing rate. This finding is consistent with that of many previous studies (e.g., Abdulai and Delgado, 1999; Lim-Applegate et al, 2002). In addition, the effect of education was positive

and significant in both models, indicating that individuals with formal education tend to diversify their income by participating in non-farm and mixed activities. Such findings support the fact that most non-farm activities like government and private wage work need education skills. This finding also confirms the outcome of many previous studies (e.g., Escobal, 2001; Atamanov and Van den Berg, 2011).

Moreover, being male had a positive effect on participating in both non-farm and mixed activities, implying that male members had more opportunity to engage in non-farm work than their female counterparts. Furthermore, the coefficient of the dependency ratio was positive and significant in non-farm model as expected, demonstrating that a family with more children tends to participate in non-farm work. This result suggests that many dependents mean that households are more likely to need additional income, thus pushing household members to engage in non-farm activities. Surprisingly, the coefficient of expenditure per capita was positive and significant in the non-farm model, suggesting that individuals from rich households have better opportunities to engage in non-farm activities than their counterparts from poor households. This also suggests that individuals who live in poor households had fewer opportunities to diversify their income risk. This result can be justified by the fact that poor households lack appropriate capital and assets, which makes it difficult for them to diversify away from farm activities. Households with high incomes have assets and better chances to access credit, and hence find it easier to engage in non-farm activities. This finding confirms the results in Figure 4 and is consistent with that of the study by Abdulai and CroleRees (2001) who found that poorer households in southern Mali have fewer opportunities to participate in non-agricultural activities.

Table 2: Multinomial logistic results of participation in non-farm activities—Full sample

Variable	Non-farm	Farm and non-farm (mixed)
Age (years)	1.056***	1.082***
	(0.000)	(0.000)
Age square	-0.003***	-0.001***
	(0.000)	(0.000)
Male (dummy)	0.331**	0.420***
	(0.036)	(0.001)
Education (years of schooling)	0.104***	0.025*
	(0.000)	(0.050)
Married (dummy)	0.206	-0.273**
	(0.167)	(0.039)
Head (dummy)	-0.060	-0.246*
	(0.708)	(0.087)
Household size (number of members)	-0.006	0.008
	(0.726)	(0.620)

continued next page

Table 2 Continued

Variable	Non-farm	Farm and non-farm (mixed)
Dependency ratio	0.181***	0.020
	(0.003)	(0.703)
Household expenditure (in SDG)	0.002***	0.001
	(0.000)	(0.891)
Owning land (dummy)	-2.964***	-0.770***
	(0.000)	(0.000)
Owning motor cycle (dummy)	1.793***	1.459***
	(0.000)	(0.000)
Distance to urban centre (in minutes)	-0.005***	-0.004***
	(0.001)	(0.000)
Electricity (dummy)	0.142	-0.109
	(0.275)	(0.386)
Access to farm credit (dummy)	-0.553**	-0.043
	(0.032)	(0.847)
Irrigation (dummy)	0.548***	-0.108
	(0.000)	(0.349)
Constant	-2.504***	-2.849***
	(0.004)	(0.000)
Observations	7238	
Pseudo R	0.21	
Wald chi^2	1838.87 (0.000)	

Values in parentheses are P values
***, ** and * denotes significance at 1%, 5% and 10% respectively

Regarding household characteristics, the coefficient of owning land was negative and significant in both models (farm and mixture of farm and non-farm), suggesting that individuals from households which own land have a lower probability of practising non-farm activities; individuals whose households lack land tend to participate in both non-farm and mixed activities. This finding confirms the results of many empirical studies (e.g., Corral and Reardon, 2001; Beyene, 2008). Interestingly, owning a motorcycle had a significant effect on both non-farm and mixture of farm and non-farm activities, implying that an individual with a motorcycle is more likely to engage in non-farm activities. This is because a motorcycle is regarded as an important means of transportation in rural areas, and thus facilitates access to work in urban centres.

The coefficient of distance to urban centres was negative and statistically significant in both non-farm and mixed models. This implies that being distant from an urban centre discourages individuals from participating in non-farm activities,

as most of these activities (such as trade and construction) are located in the urban areas. In addition, access to agricultural credit has a negative and significant effect on participation in non-farm activities. This finding indicates that access to formal agricultural credit discourages individuals from participating in non-farm activities. Unlike the results of non-farm activities, the coefficient of access to credit in the model of mixed activities was not significant. Finally, the empirical results show that the dummy variable of irrigation was positive and significant in the non-farm model, suggesting that individuals who reside in irrigated agricultural areas are more likely to participate in non-farm activities. This is because irrigated regions are closer to the urban centres where non-farm activities are available.

Second, the multinomial logit estimation results of Equation 11 for the irrigated and the rainfed agriculture sub-sectors are presented in Table 3. The IIA tests from the Hausman-McFadden and the Small-Hsiao models reported in Appendix A confirm the appropriateness of the multinomial logit model. In addition, the result of the Wald test also indicates that multinomial logit model was appropriate for our analysis.

Regarding the results of the irrigated sample in columns 2 and 3 (Table 3), most of the estimated coefficients are in line with our prior expectations. Contrary to the full sample analysis, the results of the irrigated system models revealed that age and the square of age were not statistically significant. However, similar to the full sample analysis, the coefficients of land were negative and highly statistically significant in both models, implying that individuals whose households possess land have fewer opportunities to engage in non-farm activities in irrigated agricultural system, as the lack of land is considered as a significant push factor toward non-farm activities. Interestingly, the effect of education was positive and significant only in non-farm models, while it was not significant in the models of mixture of farm and non-farm activities. This can be justified on the grounds that non-farm activities like trade and small scale industries require some educational skills. Similar to the full sample model, the effect of expenditure per capita was positive and statistically significant in the non-farm model. Unlike the full sample model, the coefficient of owning a motorcycle was not significant in both non-farm and mixed models, suggesting that irrigated schemes are closer to urban areas, where non-farm activities are available, thus means of transportation play no role in deciding non-farm activities. The results also show that distance from village to urban centres was not significant in influencing individuals' participation in the irrigated system, confirming the closeness of irrigated schemes to urban centres. In addition, the results show that the coefficient of access to farm agricultural credit was negative and significant in the non-farm model, while it was not significant in the mixed model, confirming the results of the full sample analysis.

Table 3: Multinomial logistic results of participation in non-farm activities: Irrigated and rainfed samples

Variable	Irrigated sample		Rainfed sample	
	Non-farm	Farm and non-farm (mixed)	Non-farm	Farm and non-farm (mixed)
Age (years)	0.759	0.549	0.798**	1.152***
	(0.151)	(0.281)	(0.045)	(0.000)
Age square	-0.002	-0.001	-0.001**	-0.001***
	(0.125)	(0.272)	(0.025)	(0.000)
Male (dummy)	-1.505***	-1.355***	0.708***	0.572***
	(0.001)	(0.001)	(0.001)	(0.000)
Education (years of schooling)	0.082***	0.006	0.116***	0.031*
	(0.000)	(0.737)	(0.000)	(0.072)
Married (dummy)	0.072	-0.082	0.465*	-0.365**
	(0.748)	(0.715)	(0.037)	(0.032)
Head (dummy)	-0.170	-0.556**	-0.033	-0.107
	(0.490)	(0.027)	(0.887)	(0.552)
Household size (number of members)	0.002	-0.022	-0.018	0.024
	(0.927)	(0.392)	(0.501)	(0.233)
Dependency ratio	0.121	0.023	0.246***	0.035
	(0.267)	(0.835)	(0.001)	(0.568)
Household expenditure (in SDG)	0.001*	-0.001	0.004***	0.001
	(0.050)	(0.196)	(0.000)	(0.164)
Owning land (dummy)	-3.561***	-1.241***	-2.313***	-0.339*
	(0.000)	(0.000)	(0.000)	(0.079)
Owning motor cycle (dummy)	0.701	0.594	2.126***	1.775***
	(0.238)	(0.334)	(0.000)	(0.000)
Distance to urban centre (minutes)	0.003	0.002	-0.009***	-0.005***
	(0.287)	(0.369)	(0.000)	(0.000)
Electricity (dummy)	0.019	-0.189	0.804***	0.420*
	(0.909)	(0.264)	(0.001)	(0.060)

continued next page

Table 3 Continued

Variable	Irrigated sample		Rainfed sample	
	Non-farm	Farm and non-farm (mixed)	Non-farm	Farm and non-farm (mixed)
Access to farm credit (dummy)	-0.957***	-0.397	0.884*	0.922
	(0.002)	(0.171)	(0.077)	(0.021)
Constant	1.524	1.266	-2.978**	-3.882***
	(0.357)	(0.426)	(0.010)	(0.000)
Observations	2587		4651	
Pseudo R	0.24		0.14	
Wald chi^2	867.23 (0.000)		641.03 (0.000)	

Values in parentheses are P values
***, ** and * denotes significance at 1%, 5% and 10% respectively

In accordance with the analysis of rainfed models, the results of multinomial logit estimation are reported in columns four and five (Table 3). The results indicate that most of the estimated coefficients of the rainfed sample were consistent with the analysis of the full sample models. For example, age, dependency ratio, and expenditure per capita had positive and significant effects on participation in both non-farm and mixed activities, confirming the results of the full sample models. Similar to the full sample analysis, the effects of age and age squared were positive and negative respectively, confirming the non-linear relationship between age and participation in non-farm activities. Similar to the results of the full and irrigated samples, the coefficients of land in the rainfed models were negative and significant as expected, implying that the lack of land represents an important push factor toward the non-farm activities in rainfed areas. Unlike the irrigated model, the coefficient of owning a motorcycle was positive and significant, signifying the importance of transportation means, as most of rainfed areas are located far from urban centres. In the same vein, the effect of distance was negative and significant, indicating that distance has a negative impact on participation in non-farm activities in rainfed areas. This also supports the fact that rainfed agriculture is located far from urban centres. Contradicting the full and irrigated models analyses, the effect of agricultural credit was positive and statistically significant in both non-farm and mixed models. Moreover, access to electricity was positive and significant in both these models. This indicates that accessibility to electricity stimulates the production of non-farm goods and hence increases participation in non-farm activities.

Overall, the results in Table 3 show some variations in the determinants of participation in non-farm activities between irrigated and rainfed sub-sectors. This may be due to the difference in individuals, households and location characteristics, which entails a difference in the factors that influence participation in non-farm

activities. This finding is very useful in designing appropriate policies that aim to develop rural areas considering the type of irrigation.

Determinants of participation in specific non-farm activity: Probit model analysis

For a further understanding of the participation decision of the rural population in non-farm activities, we examined the determinants of participation in specific non-farm activities. As stated in the previous section, the non-farm activities in rural areas are classified into two main categories: wage work and self-employment activities. In addition, in order to determine whether the two subsets can be pooled together or not, we used the Chow test. The Chow statistic in Appendix B indicates that separate models for each of the two categories (i.e., wage work and self-employment) fit the data better than a single model from pooled data. Therefore we estimated separate models for non-farm activities. The estimation results of Equation 12 using a probit model for both irrigated and rainfed samples are presented in Table 4.

The results in Table 4 show some variations in the effect of the factors that influence participation in specific non-farm activities in the irrigated and the rainfed samples. First, the results of the irrigated sample indicate that the effect of age and the square of age were not significant, contradicting the outcome of the rainfed analysis. Education was positive and significant in both of the irrigated models. Interestingly, the impact of owning land was negative and significant, confirming the outcome of the previous analysis.

Second, regarding the analysis of the rainfed sample, the results in column four and five (Table 4) reveal that the explanatory variables have different effects on the probability of participation in wage employment and self-employment activities. The results also indicate that the effect of age was positive and statistically significant in participation in both wage and self-employment. However, the impact of age squared was negative and significant in both models, supporting the non-linearity between age and participation in non-farm activities. Interestingly, the coefficient of education was positive and significant in the wage employment model, while it was negative and significant in self-employment work. This suggests that educated people have a better opportunity to participate in wage employment. Educated individuals are discouraged from engagement in self-employment. This can be justified by the fact that wage employment, like private and government work, requires education skills, while self-employment does not need education qualifications. Moreover, the coefficient of per capita expenditure was positive and significant in the self-employment model. This means that individuals belonging to rich households are more likely to participate in self-employment than in wage work. This is because individuals with high incomes have better opportunities to access assets that facilitate their participation in self-employment like trade and business enterprises. The effect of farm credit was negative and significant in the wage work model of the irrigated sample, while it was positive and significant in the model of self-employment for the rainfed model.

Table 4: Probit results of participation in non-farm activities (marginal effects)

	Irrigated sample		Rainfed sample	
Variable	Wage work	Self-employment	Wage work	Self-employment
Age (years)	0.012 (0.892)	0.104 (0.184)	0.118** (0.028)	0.132** (0.012)
Age square	-0.001 (0.859)	-0.003* (0.050)	-0.003** (0.006)	-0.002* (0.052)
Male (dummy)	-0.193 (0.000)	0.020 (0.646)	0.116*** (0.000)	0.039 (0.141)
Education (years of schooling)	0.023*** (0.000)	-0.011*** (0.000)	0.019*** (0.000)	-0.003 (0.239)
Married (dummy)	-0.051 (0.189)	0.057* (0.062)	-0.038 (0.240)	0.040 (0.188)
Head (dummy)	-0.072* (0.087)	0.031 (0.353)	-0.041 (0.239)	0.024 (0.455)
Household size (number of members)	-0.005 (0.265)	0.006 (0.112)	0.005 (0.205)	0.000 (0.996)
Dependency ratio	0.012 (0.494)	0.001 (0.954)	-0.012 (0.312)	0.022** (0.042)
Household expenditure (in SDG)	0.001 (0.616)	0.001 (0.158)	0.003 (0.764)	0.002** (0.024)
Owning land (dummy)	-0.285*** (0.000)	-0.092*** (0.000)	-0.131*** (0.000)	-0.067** (0.010)
Owning motor cycle (dummy)	0.076 (0.436)	0.023 (0.770)	0.040 (0.499)	0.187*** (0.002)
Distance to urban centre (in minutes)	0.000 (0.415)	0.000 (0.232)	-0.001*** (0.000)	-0.001*** (0.008)
Electricity (dummy)	-0.055* (0.060)	0.011 (0.635)	0.040 (0.260)	0.053 (0.115)
Access to farm credit (dummy)	-0.158*** (0.006)	0.008 (0.872)	0.013 (0.848)	0.204*** (0.004)
Observations	2587	2587	4651	4651
Pseudo R	0.11	0.034	0.66	0.051
Likelihood ratio (LR) chi2	268.63 (0.000)	66.37 (0.000)	163.22 (0.000)	118.97 (0.000)

Values in parentheses are P values
***, ** and * denotes significance at 1%, 5% and 10% respectively

Determinants of participation in non-farm activities: A gender perspective

To get further insight into the factors that affect the decisions of individuals to participate in non-farm activities, this section examines the determinants of participation in non-farm activities for both males and females. The estimation results of the probit models of Equation 12 for the gendered level are presented in Table 5. Specifically, the results show some symptoms of gender inequality in the factors that influence participation in non-farm activities. The coefficients of age and age squared in the male model were positive and negative respectively, confirming the non-linearity between age and participation in non-farm activities that are reported in the full, urban and rural samples. However, the impact of age and age squared turn out to be insignificant in the female model. In addition, the coefficient of education in the male model had a greater value than the education coefficient of the female model. This implies that education has more impact on the participation of males in non-farm activities. This is may be due to low rate of education enrolment of females in rural areas. Moreover, the coefficient of land was bigger in the male model and highly significant, suggesting that men own more land than their female counterparts. Interestingly, the results show that the coefficient of being married was positive and statistically significant in the female model while it was not significant in the male sample. This finding can be explained by the fact that women in rural Sudan are the main contributors to household income; thus, a large proportion of females participate in the labour market, particularly those who are married with children. Moreover, the significance of the married variable in the female sample indicates that most married females engage in non-farm activities.

Furthermore, the results show that the coefficient of access to electricity was positive and significant in the female model, implying that women whose households have access to electricity have a better opportunity to engage in non-farm activities than their male counterparts. This can be explained by the fact that a female whose household has access to electricity has a better opportunity to practise some non-farm activities like processing food. Finally, access to farm credit had a positive and significant effect in the female model, suggesting that a woman with access to credit enjoys a higher opportunity to participate in non-farm activities.

Table 5: Probit results of participation in non-farm activities—Male and female (marginal effects)

Variable	Male	Female
Age (years)	0.231***	0.004
	(0.000)	(0.937)
Age square	-0.001***	-0.002
	(0.000)	(0.774)
Education (years of schooling)	0.018***	0.010
	(0.000)	(0.190)
Married (dummy)	-0.029	0.134**
	(0.364)	(0.031)
Head (dummy)	0.002	0.081
	(0.954)	(0.373)
Household size (number of members)	0.009	0.015*
	(0.298)	(0.078)
Dependency ratio	0.009	0.003
	(0.451)	(0.902)
Household expenditure (in SDG)	-0.328	0.001
	(0.171)	(0.83)
Owning land (dummy)	-0.327***	-0.259***
	(0.000)	(001)
Owning motor cycle (dummy)	0.165***	0.474***
	(0.004)	(0.005)
Distance to urban centre (minutes)	-0.001***	-0.004***
	(0.003)	(0.000)
Electricity (dummy)	-0.025	0.195*
	(0.306)	(0.066)
Access to farm credit (dummy)	-0.078	0.377**
	(0.103)	(0.018)
Irrigation (dummy)	-0.003	0.254**
	(876)	(0.010)
Observations	5703	1535
Pseudo R	0.11	0.29
LR chi2	519.11 (0.000)	226.71 (0.000)

Values in parentheses are P values

***, ** and * denotes significance at 1%, 5% and 10% respectively

Determinants of Participation in Non-farm Activities by Income Quintile

Finally, to understand whether the determinants of participation decision in non-farm activities vary among different income groups, Table 6 reports the results of probit estimation for the five income quintiles.

Table 6: Probit results of participation in non-farm activities by income quintile (marginal effects)

Variable	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Age (years)	0.094	0.534***	0.255**	0.369***	0.020
	(0.309)	(0.000)	(0.015)	(0.005)	(0.896)
Age square	-0.003	-0.000***	-0.001**	-0.002***	0.001
	(0.324)	(0.002)	(0.016)	(0.001)	(0.887)
Male (dummy)	0.150***	0.081	0.127**	0.111	-0.091
	(0.002)	(0.178)	(0.037)	(0.121)	(0.160)
Education (years of schooling)	0.020***	0.023***	0.016***	0.017***	0.018***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Married (dummy)	-0.022	-0.092	0.028	-0.083	0.155***
	(0.708)	(0.132)	(0.628)	(0.143)	(0.008)
Head (dummy)	-0.019	0.014	-0.069	-0.031	-0.045
	(0.750)	(0.836)	(0.260)	(0.632)	(0.501)
Household size (number of members)	-0.002	0.004	0.010	-0.012	0.005
	(0.726)	(0.544)	(0.186)	(0.142)	(0.609)
Dependency ratio	0.016	-0.021	0.001	0.079***	-0.022
	(0.367)	(0.391)	(0.993)	(0.004)	(0.535)
Household expenditure (in SDG)	-0.001	0.003	0.001	0.001	0.001**
	(0.595)	(0.882)	(0.757)	(0.558)	(0.026)
Owning Land (dummy)	-0.333***	-0.326***	-0.320***	-0.358***	-0.281***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Owning motor cycle (dummy)	0.231*	0.364**	0.187**	0.122	0.256**
	(0.087)	(0.015)	(0.046)	(0.275)	(0.019)
Distance to urban centre (minutes)	-0.002***	-0.003***	0.001	0.004	0.001
	(0.000)	(0.000)	(0.605)	(0.352)	(0.910)

continued next page

Table 6 Continued

Variable	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Electricity (dummy)	-0.117*	-0.013	-0.011	0.018	0.055
	(0.098)	(0.798)	(0.808)	(0.733)	(0.302)
Access to farm credit (dummy)	-0.037	-0.008	0.077	-0.138	-0.048
	(0.725)	(0.944)	(0.445)	(0.170)	(0.608)
Irrigation (dummy)	0.094**	-0.035	0.030	0.022	-0.037
	(0.026)	(0.467)	(0.493)	(0.673)	(0.489)
Observations	2030	1747	1443	1180	838
Pseudo R	0.10	0.16	0.12	0.18	0.16
LR chi2	135.91 (0.000)	188.72 (0.000)	127.76 (0.000)	164.45 (0.000)	117.58 (0.000)

Values in parentheses are P values
***, ** and * denotes significance at the 1%, 5% and 10% respectively

As Table 6 shows, the coefficient of education was positive and statistically significant across all income quintiles, confirming the results obtained by the analysis of the full, urban and rural sample models. Excluding the first and fifth income quintiles, the coefficients of age and age squared were positive and negative respectively in the middle-income quintiles. Interestingly, the effect of per capita expenditure was positive and significant only in the highest income quintile. This indicates that individuals belonging to rich households have a better opportunity to access non-farm activities. This finding corroborates the results obtained by multinomial logit model in Tables 2 and 3.

Overall, these results indicate some variations in the factors that influence participation in non-farm activities according to income status of households. This finding suggests that there is a symptom of income inequality in rural Sudan affecting the participation decision of the population in non-farm labour market. Therefore, formulating policies that encourage participation of disadvantaged groups in non-farm activities might mitigate the problem of income inequality in rural areas.

6. Conclusion and policy implications

This study examined the patterns and determinants of the decision to participate in non-farm activities in rural Sudan. The study used the National Baseline Household Survey (NBHS) database 2009 for both the aggregate and sectoral levels of agricultural irrigation systems. For the robustness check, the analysis was also executed for different income groups and for males and females.

The study shows that non-farm income is an important source of livelihood, contributing about 43% to the total income in rural Sudan. This result is in line with most of previous studies conducted in the other sub-Saharan African countries (e.g., Reardon, 1997, Beyene, 2008; Babatunde and Qaim, 2010). The results also revealed that non-farm wage employment represents the highest share of non-farm income amounting to 53% while self-employment contributes 47%.

The empirical analysis indicates that education level, age, per capita expenditure, dependency ratio, and owning a motorcycle were the most significant factors that encourage individuals to participate in non-farm activities. Square of age, owning land, distance to urban centres, and access to farm credit had a negative and significant impact on participation in non-farm activities. In addition, households residing in an irrigated agricultural system had a higher probability of engaging in non-farm activities than those living in a rainfed system. The empirical results also indicate some variations in the determinants of participation in wage employment and self-employment.

Surprisingly, the impact of household income was positive and statistically significant, suggesting that individuals from rich households have a better opportunity to engage in non-farm activities than their poor counterparts This is because households with higher income possess assets and better chances to access credit, hence enabling their members to easily engage in non-farm activities. Put differently, this also implies that individuals living in poor households have fewer opportunities to diversify their income. Moreover, the results reveal that the determinants of participation in non-farm activities vary between the irrigated and the rainfed agriculture sectors. The analysis also indicates some symptoms of gender and income inequality in the factors that affect participation in non-farm activities.

Based on these findings, many policy implications can be drawn. First and foremost, the entry barriers to non-farm activities should be removed to facilitate the participation of the disadvantaged household members like the poor and women in

non-farm activities. Therefore, policy measures that enhance infrastructure, education and access to credit should be adopted, so as to increase the capacity of households (particularly poor households), to participate in non-farm activities. In addition, strategies that aim to reduce poverty in rural areas should focus on non-farm activities, as a complementary source of income. Thus, microfinance projects that target poor households need not only to finance agriculture enterprises, but non-farm activities should be given considerable attention as a diversification strategy.

Since agriculture is still the largest source of livelihood in rural Sudan, policy makers need also to pay a great deal of attention to enhancing agriculture through supporting new technologies that promote crop and livestock production. In addition, non-farm activities should gain an equivalent focus; this is because farming alone may fail to guarantee a sufficient livelihood for most farming households. Thus, non-farm activities can bridge the gap by directly increasing household income and providing cash that can be invested in farm inputs to increase agricultural productivity. The attention therefore should be to adopt policies that aim to enhance the role of both sectors (i.e., farm and non-farm) in improving the rural economy and the welfare of poor rural households. Specifically, approaches towards developing agriculture need to be balanced by those that encourage investment in small-scale enterprises. For example, access to credit can support both farm and non-farm businesses. Moreover, the relevant government entities should pay serious attention to physical infrastructure that reduces transportation and transaction costs in both sectors so as to increase overall employment opportunities. Furthermore, the disparities in factors that affect participation in non-farm activities across irrigated and rainfed system and between males and females indicate the need for policy makers to consider the specific nature of gender and location in supporting access to non-farm activities.

Finally, to complete the view on the non-farm activities in rural Sudan, the issue of non-farm activities needs further analysis in many dimensions. First, it would be important to analyse the effect of non-farm income on poverty reduction and inequality in rural areas. Second, an empirical study needs to be conducted to examine whether farm and non-farm incomes crowd-out or crowd-in each other. Finally, a study to investigate the impact of non-farm income on food security and nutrition would be very useful.

Notes

1. The agriculture sector in Sudan is divided into two main sub-sectors, namely irrigated and rainfed.

2. We tested the all models for multicollinerity problem using variance inflation factor (VIF). The mean of the VIF was close to unity in all models, indicating no multicollinerity problem.

3. The Smith and Blundell (1986) test involves specifying that the exogeneity of one or more explanatory variables is under suspicion. Under the null hypothesis, the models are appropriately specified with all explanatory variables as exogenous. Under the alternative hypothesis, the suspected endogenous variables are expressed as linear projections of a set of instruments, and the residuals from those first-stage regressions are added to the model. Under the null hypothesis, these residuals should have no explanatory power

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Appendixes

Appendix A: Tests of Independence of Irrelevant Alternatives (IIA) for the multinomial logit

Table A1: Tests (IIA) for participation in non-farm activities—Full sample model

Small-Hsiao tests of IIA assumption		
Omitted	Chi^2	$P > chi^2$
Non-farm	-1806.485	1.000
Farm and non-farm	-2121.403	1.000
Hausman tests of IIA assumption		
Omitted	Chi^2	$P > chi^2$
Non-farm	-3.29	1.000
Farm and non-farm	-183.10	1.000

Table A2: Tests (IIA) for participation in non-farm activities—Irrigated sub-sample model

Small-Hsiao tests of IIA assumption		
Omitted	Chi^2	$P > chi^2$
Non-farm	3.12	1.000
Farm and non-farm	7.11	0.9003
Hausman tests of IIA assumption		
Omitted	Chi^2	$P > chi^2$
Non-farm	6.51	0.9256
Farm and non-farm	6.26	0.9361

Table A3: Tests (IIA) for participation in non-farm activities—Rainfed sub-sample model

Small-Hsiao tests of IIA assumption		
Omitted	Chi^2	$P > chi^2$
Non-farm	-123	1.000
Farm and non-farm	-24	1.000
Hausman tests of IIA assumption		
Omitted	Chi^2	$P > chi^2$
Non-farm	1.53	1.000
Farm and non-farm	58.71	0.000

Tests under the null hypothesis of odds (Outcome-J vs. Outcome-K) are independent of other alternatives.

Appendix B: Chow tests

Chow tests: Null hypothesis of pooling		
	Chow test	P value
Wage work model	66.55	(0.000)
Self-employment model	29.39	(0.009)

Mission

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