Global Journal of human-social science: E Economics
Volume 15 Issue 3 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-460X & Print ISSN: 0975-587X

Off-Farm Income's Share and Farm Investment among Small-Scale Farmers in North-Central Nigeria: The Heckman's Selection Model Approach

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GJHSS-E Classification : FOR Code: 149999

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Off-Farm Income's Share and Farm Investment among Small-Scale Farmers in North-Central Nigeria: The Heckman's Selection Model Approach

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I. Introduction

The agricultural landscape in Nigeria is dominated by rural-based small-scale farmers. Inadequate finance and impeded access to farm credit facilities constitute the major constraint faced by these farmers. Hence, farmers resorted to off-farm work in order to generate fund for farm investment (Ogbanje, Chidebelu & Nweze, 2014a). Off-farm work refers to activities from which farmers earn income apart from their own farm. In Nigeria, off-farm work is broadly disaggregated into agricultural wage employment, non-agricultural wage employment, and self-employment (Babatunde, Olagunju, Fakayode & Adejobi, 2010; Ibekwe *et al*., 2010; Ogbanje, Chidebelu & Nweze, 2014b).

The off-farm sector is of importance to the rural economy because of its production linkages and employment effects, while the income it provided to rural households could represent a substantial and sometimes growing share of farm capital (Davis, 2003; Zeller, 2010). The income obtained off-farm doubles as risk minimisation and household income stabilisation strategies in both developed and developing countries (Babatunde, 2008; Blank, Erickson, Nehring & Hallahan, 2009; Briggeman, 2011). Off-farm income also insures against agricultural production risk and market failure (Reardon, 1997; Ellis & Freeman, 2004). It follows that off-farm income's share is a measure of the extent of farm household reliance on off-farm income. Ogbanje (2014) found that off-farm income share of household income constituted 50.28% of household income of small-scale farmers in North-Central Nigeria.

Some researchers have indicated that the inadequacy of farm income and high prevalence of poverty have resulted in the inability of small-scale farmers to meaningfully invest in farm business (Lambert & Bayda, 2005; Kwon, Orazem & Otto, 2006). Others have contended that farmers' resort to sourcing credit from financial intermediaries has not brought the much anticipated farm capital relief (Musser, White & McKissick, 1977; Bagachawa, 2000; Obike, Ukoha & Nwajiuba, 2007). Furthermore, as the farmer allocates his endowed time among farm work, off-farm work, and leisure, off-farm work diverts critical productive resources from the farm sector. The resultant and emerging dual farm structure, which could affect food production, therefore, suggests that so many factors – socioeconomic and farm financial characteristics – could account for participation in off-farm work as well as the amount of off-farm income's share of household income invested in farming.

The study was designed to determine the effect of socioeconomic and farm financial characteristics of farmers on the probability of participation in off-farm work and amount of off-farm income's share of household income invested in farming. Studies on off-farm work are of great importance to agrarian nations and economies in transition. They are also necessitated by the imperativeness to forestall dual farm structure from impairing food production. In addition, the International Fund for Agricultural Development and stakeholders in rural finance could derive models from off-farm work studies that would guarantee adequate

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finance for sustainable food production and rural development. Finally, findings from studies of this nature could enhance proper management of resources accruing from off-farm work, and thus, enable small-scale farmers to take advantage of the policy thrust on agribusiness and financial inclusion.

a) Theoretical formulation of Heckman's two-stage selection model

Limited dependent variables are common in social and health studies. The primary characteristics of such variables are censoring and truncation (Vance, 2006). Truncation, which is an effect of data gathering rather than data generation, occurs when sample data are drawn from a subset of a larger population of interest. Thus, a truncated distribution is the part of a larger, untruncated distribution. Assuming that an income survey was administered on a limited subset of a population (e.g. those whose incomes are above a certain threshold), the dependent variable in the survey would be observed only for a portion of the whole distribution. The task of modeling is to use that limited information—a truncated distribution—to infer the income distribution for the entire population. Censoring occurs when all values in a certain range of a dependent variable are transformed to a single value. Using the above example of population income, censoring differs from truncation in that the data collection may include the entire population, but below the given threshold, incomes are coded as zero. Under this condition, researchers may estimate a regression model for a larger population using both the censored and the uncensored data (Cragg, 1971; Vance, 2006).

The central task of analysing limited dependent variables is to use the truncated distribution or censored data to infer the untruncated or uncensored distribution for the entire population. In the context of regression analysis, it is typically assumed that the dependent variable follows a normal distribution. The challenge, then, is to develop moments (mean and variance) of the truncated or censored normal distribution. Theorems of such moments exist. In these theorems, moments of truncated or censored normal distributions involve a key factor called the inverse Mills ratio, or hazard function, which is commonly denoted as. Heckman's two-stage sample selection model, a variant of double hurdle model, uses the inverse Mills ratio to estimate the outcome regression.

The Heckman's model essentially applies the moments of the incidentally truncated bivariate normal distribution to a data generating process. The basic selection equation in Heckman's model is stated as follows:

$$\boldsymbol{Z_i^* = w_i x_i + u_i}$$

where:

Zi^* = dichotomous and continuous dependent variable,

x_i = exogenous variable,

w_i = coefficient of exogenous variable, and

ui = error term.

The conditions for Zi are set out as follows:

$$z_i = \begin{Bmatrix} 1\ if\ z_i^* > 0 \\ 0\ if\ z_i^* \leq 0 \end{Bmatrix}$$

The basic outcome equation is as follows:

$$\boldsymbol{y_i = \begin{Bmatrix} x_i\beta + \epsilon_i & if\ z_i^* > 0 \\ & if\ z_i^* \leq 0 \end{Bmatrix}}$$

According to Harris, Blank, Erickson & Hallahan (2010), the investment decision could be viewed as a binary one, i.e. to invest or not. This can be analysed using a dichotomous choice model. However, farmers are also faced with the decision of how much to invest. According to Cragg (1971) and Smith (2002), two hurdles are involved in the process of investment decisions, which can be determined separately or simultaneously. In order to observe a positive level of investment, two separate hurdles must be passed.

These two significant decisions, according to Ahituv and Kimhi (2002), determined the growth of the farmer's earnings through his life-cycle paths in terms of both human and physical capital. At the macro level, the decisions taken by many individual farmers were essential to the overall development of the agricultural sector and the economy as a whole, resulting in major policy implications.

Available empirical findings about inter-temporal analysis of employment choice (Nakamura & Nakamura, 1985; Gould & Saupe, 1989; Weiss, 1997; Corsi & Findeis, 2000) agreed that individuals with previous off-farm employment record were more likely to participate on the off-farm labour market than those who had not (and vice versa).

II. Methodology

The study area was North-Central Nigeria. The region comprised six states, namely, Benue, Kogi, Nasarawa, Plateau, Kwara and Niger, with a total land mass of 296,898 km^2 and total population of 20.36 million people. The region is bounded in the north by Bauchi, Kaduna, Zamfara, and Kebbi States; in the south by Cross-River, Ebonyi, Enugu, Edo, Ondo, Ekiti, Osun and Oyo States; in the east by Taraba State and Cameroon; and in the west by the Republic of Benin. Situated between latitudes $6^0$30" N and $11^0$20" N and longitudes 7^0E and 10^0 E, the region has average annual rainfall that ranges from 1,500 mm to 1,800 mm, with average annual temperature varying between 20^0C and 35^0C. North Central Nigeria has 6.6 million hectares of land under cultivation, with rain-fed agriculture accounting for about 90 percent of the production systems (NBS, 2008). Majority of the populace are in agriculture, with farm size ranging from 0.4 to 4.0 ha (FAO, 2002; NFRA, 2008).

The region features prominently in national agricultural production statistics. For instance, Benue and Kogi States were among the states of the federation that cultivated over 200,000 ha of cassava in 2007, with over two million metric tonnes of cassava output. For yam, Benue and Niger States cultivated over 200,000 ha and harvested over two million metric tonnes. Niger State was among the states that cultivated over 300,000 ha of maize and sorghum, with output of over 400,000 metric tonnes. Niger, Benue and Kwara States were among the states that cultivated over 100,000 ha of rice with an output of over 200,000 metric tonnes. For legumes (cowpea, soyabean, bambara nut, and sesame), Niger, Benue and Kogi States ranked among the highest producers in the country (NFRA, 2008).

Multistage sampling technique was used to select respondents for the study. Using simple random sampling in stage one, Benue, Kogi and Niger States were selected from the region. In stage two, simple random sampling was used to select two agricultural zones from each state namely, zones A and C from Benue State, zones B and D from Kogi State, and zones A and B from Niger State. In stage three, simple random sampling was used to select two local government areas (LGAs) from each agricultural zone. In Benue State, the LGAs were Ukum and Katsina-Ala from zone A, and Otukpo and Oju from zone C. In Kogi State, the LGAs were Dekina and Bassa from zone B, and Ofu and Olamaboro from zone D. In Niger State, the LGAs were Shirorro and Paikoro from zone A, and Gbako and Lavun from zone B. In stage four, three farming communities were randomly selected from each LGA. Finally, using stratified random sampling, 10 small-scale farmers (five participants and five non-participants in off-farm work) were selected from each farming community giving a total sample size of 360 respondents.

Data for the study were obtained from primary source with the aid of pre-tested structured questionnaire, which was validated as recommended by Kerlinger (1973). Test-retest method and Pearson's product moment correlation coefficient were used to ascertain the reliability of the instrument. Heckman's two-stage selection model was used analyse the data for the study.

a) Empirical formulation of Heckman's two-stage selection model

The model had two dependent variables – the dichotomous (y_1) and continuous (y_2). The specification was as follows:

$$Y^* = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + b_{12}x_{12} + b_{13}x_{13} + b_{14}x_{14} + b_{15}x_{15} + b_{16}x_{16} + e_i$$

$Y^* = Y_1$ and Y_2,

Y_1 = probability of participation in off-farm work (1 = participated, 0 otherwise),

Y_2 = amount of off-farm income's share of household income invested in farming (₦),

X_1 = age of farmer (years),

X_2 = sex of household head (1 = male; 2 = female),

X_3 = education of farmer (number of years spent in formal educational institutions),

X_4 = household size (number of people in a farm household),

X_5 = farming experience (years),

X_6 = total farm size (ha),

X_7 = total crop revenue (₦),

X_8 = distance to market (km),

X_9 = primary occupation (1 = farming; 0 otherwise),

X_{10} = land ownership (1 = own farm land; 0 otherwise),

X_{11} = government payment (₦),

X_{12} = ratio of farm assets to household assets,

X_{13} = operating profit margin,

X_{14} = asset turnover ratio,

X_{15} = capital input (₦),

X_{16} = farm capital (₦).

β = coefficient of explanatory variables.

III. Results and Discussion

a) Participation in Off-farm Work and Amount of Off-farm Income's Share invested in Farming

The analysis of the probability of participation in off-farm work and the amount of off-farm income's share invested in farming is as presented in Table 1. The lambda of the model provided the proportion of total variability not explained, which was 1.38%. This meant that the variables in the model accounted for 98.62% of the variation in the amount of off-farm income's share of household income that was invested in farming. The chi-square of the model was statistically significant ($p < 0.01$). Hence, socioeconomic and farm financial characteristics of farmers have significant effect on their participation in off-farm work and the amount of off-farm income's share of household income that was invested in farming.

In the first hurdle, age had no significant effect on the probability of participation. In the second model, however, age significantly ($p < 0.01$) reduced the amount of off-farm income's share as a percentage of household income invested in farming. A 10% increase in the age of farmers would result in 0.01% decrease in the amount of off-farm income's share invested in farming. As a farmer advanced in age, the intensity of off-farm work, as well as the associated income, reduced. More so, the tempo of farm activities and the level of total investment dropped. All these contributed to the reduction in total household income and the off-farm income's share that was reserved for farm investment. The results of the two models contradicted Harris *et al.* (2010) and El-Osta (2011) where age did not significantly affect off-farm work participation decision or the level of capital invested in farming.

In the first hurdle, farm size had no significant effect on the probability of participation but significantly ($p < 0.01$) reduced the amount of off-farm income's share that was invested in farming. The implication is that a 10% increase in farm size would result in 0.05% decrease in the amount of off-farm income's share invested in farming. The inverse relationship could be attributed to the fact that increasing farm size imposed restriction on off-farm work participation as well as the income from the sector. Although, Harris *et al.* (2010) showed empirically that larger farmers required larger capital expenditures, as the farm size of a household increased, off-farm work and off-farm income declined, thereby reducing the amount of off-farm income's share invested in farming.

In the second hurdle, government payment significantly ($p < 0.01$) reduced the amount of off-farm income's share invested in farming, implying that a 10% increase in government would result in 0.001% decrease in the amount of off-farm income's share invested in farming. Those who were in government service would pay relatively less attention to farming and, hence, reallocated their off-farm income's share to the non-farm sector. Thus, the more of government payment they received, the farther away they drifted from farming. In Harris *et al.* (2010), government payment did not significantly affect investment in the second hurdle.

In the first hurdle, operating profit margin significantly ($p < 0.05$) increased the probability of participating in off-farm work. This implied that a 10% increase in operating profit margin would increase the probability in off-farm work participation by 0.74%. This would have arisen from the prudent management of funds injected into farm enterprises. The benefit obtained in the previous period would have informed and sustained the resolve to participate in off-farm work in line with life-cycle hypothesis of Ahituv and Kimhi (2002). The result was consistent with Lagerkvist, Larsen & Olson (2006), suggesting the possibility of larger farm firm growth.

Capital input significantly ($p < 0.05$) reduced the probability of participating in off-farm work. The implication was that a 10% increase in capital would decrease the probability of off-farm work participation by 0.003%. For some farmers to participate in off-farm work, they obtained loan or diverted part of their credit for farm investment to off-farm sector. This loan, in rural areas, attracted high interest rate (Nweze, 1990). Again, off-farm businesses were more vulnerable to taxes from various authorities than farm businesses. Thus, capital input, which comprised interest paid on loan and taxes, could discourage and limit participation in off-farm work.

The ratio of farm asset to household asset significantly ($p < 0.05$) increased the share of off-farm income that was invested in farming. The implication was that a 10% increase in the ratio of farm asset to household asset would increase the investible off-farm income's share by 0.25%. Higher ratios shifted emphasis towards farm assets relative to household assets. More farm assets would require maintenance and, eventually, replacement at the end of the useful period. In either of these scenarios, off-farm share came handy.

Asset turnover ratio significantly ($p < 0.01$) increased the amount of off-farm income's share that was invested in farming. This implied that a 10% increase in asset turnover ratio would raise farm-investible off-farm income's share by 0.05%. In other words, for every one naira of asset held, a farm household generated annual off-farm income of ₦0.0048. Hence, the more a farm household converted the utilisation of its farm assets to income, the more it would invest its off-farm income's share in farming. According to Myyra, Pietola & Heikkila (2011), this ratio described the capital rotation speed in agriculture.

Table 1: Participation in off-farm work and amount of off-farm income's share invested in farming (n=360)

	Independent variables	Coefficient	z	$P => \|z\|$
Decision to participate in off-farm work model	Age (years)	0.0881	0.93	0.35
	Sex (1=male, 0 otherwise)	-0.5434	-0.56	0.578
	Education (years)	11.2431	2.06**	0.039
	Household size	0.9972	2.19**	0.029
	Farming experience (years)	-0.1406	-1.60	0.11
	Total farm size	-0.9168	-1.44	0.151
	Total crop revenue (₦)	0.0003	0.45	0.655
	Distance to market (km)	-0.3432	-0.84	0.401
	Primary occupation (1=farming, 0 otherwise)	2.6734	1.48	0.14
	Land ownership (1=own farmland, 0 otherwise)	-284.1234	-13.00*	0.000
	Government payment (₦)	0.00009	1.86	0.063

	Ratio of farm asset to household asset	-3.8003	-1.56	0.118
	Operating profit margin	798.1200	2.12**	0.034
	Asset turnover ratio	-0.0385	-0.32	0.748
	Capital input (₦)	-0.0079	-2.12**	0.034
	Farm capital (₦)	0.0009	-1.25	0.212
Amount of off-farm income's share invested in farming (₦)	Constant	0.2919	8.28*	0.000
	Age (years)	-0.0013	-4.08*	0.000
	Sex (1=male, 0 otherwise)	-0.0006	-0.09	0.93
	Education (years)	0.0171	2.53**	0.011
	Household size	0.0012	1.15	0.252
	Farming experience (years)	0.0004	1.68	0.093
	Total farm size	-0.0052	-3.49*	0.000
	Total crop revenue (₦)	0.000004	2.25**	0.024
	Distance to market (km)	-0.0004	-0.37	0.712
	Primary occupation (1=farming, 0 otherwise)	0.0107	2.12**	0.034
	Land ownership (1=own farmland, 0 otherwise)	-	-	-
	Government payment (₦)	-0.0001	-12.94*	0.000
	Ratio of farm asset to household asset	0.0245	2.00**	0.046
	Operating profit margin	0.0737	0.30	0.764
	Asset turnover ratio	0.0048	6.65*	0.000
	Capital input (₦)	0.0003	0.78	0.437
	Farm capital (N)	0.00001	5.67*	0.000

, significant at 1% and 5%, respectively; Lambda = 0.01377; rho = 0.48381; Sigma = 0.02846; $Chi^2(15) = 631.33$; Prob > $chi^2 = 0.000$;*

Source: computed from field survey, 2013

Farm capital significantly ($p < 0.01$) decreased the amount of off-farm income's share invested in farming, implying that a 10% increase in farm capital would reduce farm-investible off-farm income's share by 0.0001%. This meant that farmers with low farm capital level would invest more of their off-farm income's share in farming so as to shore up their farm capital level. In line with Mundlak (1993) that capital constraints constituted major determinants of the rate of adoption of new technologies, the investment of off-farm income's share would then raise the level of acquisition and utilisation of relevant technologies.

Education significantly ($p < 0.05$) reduced the odds of participating in off-farm work. The implication was that a 10% increase in the number of years of formal education would increase the probability of off-farm work participation. In Nigeria, the elites either abhorred farming or substituted farm labour with capital. This increased their probability to participate in off-farm work. In the second model, education increased the amount of off-farm income's share ($p < 0.05$) that was invested in farming. This implied that more number of years of formal education increased the amount of off-farm income's share that was allocated to farm investment. Higher level of education conferred on farmers increasing efficiency in farm management skills. This was in line with Harris *et al.* (2010) that highly educated farm operators used off-farm income to finance farm investment.

The first hurdle showed that household size significantly ($p < 0.05$) increased the probability of participating in off-farm. Hence, a 10% increase in household size would raise the probability of off-farm work participation by 0.01%. Large household implied increased consumption expenditure profile. A rational head of large household would seek for additional sources of income or investment that would smoothen the path of consumption. Therefore, the need to participate in off-farm work heightened. This was in line with the push factor diversification of Reardon (1997) which induced households to manage income and consumption uncertainties via diversification. In the second model, however, household size had no significant effect on the amount of off-farm income's share invested in farming.

Land ownership significantly ($p < 0.01$) increased the odd of participating in off-farm work, implying that increase in land ownership by 10% would lead to increase in the probability of off-farm work participation by 0.001%. Farmers who operated on own

farmland could afford to intensify investment on the land and even exploit expansion effect as against those who held temporary farmland rights. Own farm land operators would normally be inclined to seek investment fund off-farm where credit constraint was prevalent. This finding was inconsistent with Jerome (2002) that more secure rights improved household's ability and readiness to increase investment, provided better access to credit, and reduced transaction cost associated with land transfers. Besley (1995) corroborated that more secure tenure to a plot of land increased the probability that individuals would undertake a wide range of investment on the land. This variable, however, did not have significant effect on the amount of off-farm income's share invested in farming.

Total crop revenue significantly ($p < 0.05$) increased the amount of off-farm income's share that was invested in farming. This meant that additional 10% of crop revenue would increase farm-investible off-farm income's share by 0.00004%. The more income a farm household generated from the farm sector, the more of its off-farm income's share it invested in farming. This is because the economic well-being of a farm is evaluated in terms of farm income. Myyra *et al.* (2011) noted that commercial farms were profitable if they produced annual income and accumulated expected value over time.

Primary occupation significantly ($p < 0.05$) increased the amount of off-farm income's share invested in farming. This meant that if additional 10% of farmers chose farming as primary occupation, farm-investible off-farm income's share would rise by 0.11%. This implied that farmers who derived their livelihood largely from farming reinvested more off-farm income's share in farming. This, according to Kwon *et al.* (2006), was in response to large fluctuations in farm income faced by farm households.

IV. Conclusion and Recommendations

Surrounding business and environmental factors affect shape the decision to seek farm capital relief from the off-farm sector. These factors also determine the proportion of off-farm income that could be transferred to farm investment. Thus, it is axiomatic that the small-scale farmer exercises some independent level of farm investment decision. Some inhibitive factors beyond his control are also in this ambient environment.

It was recommended that the government and the International Fund for Agricultural Development should consciously regulate the business environment in the rural areas in a way that farmers invest off-farm income in farming. Policy thrust should focus on reduction in interest and tax rates for small-scale farmers; deliberate transition to market-oriented agricultural production that would improve crop revenue; and ease of asset acquisition. These measures would strengthen production chain linkages and facilitate employment generation, thereby sustaining agribusiness development in Nigeria.

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