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Discriminant Function Analysis of Factors affecting Off-farm Diversification among Small-scale Farmers in North Central Nigeria

Christopher Elaigwu Ogbanje[1,2*], Sonny A.N.D. Chidebelu[2], & Noble Jackson Nweze[2]
1. Ph.D. student, Department of Agricultural Economics, University of Nigeria, Nsukka, Enugu State, Nigeria
2. Department of Agricultural Economics, University of Nigeria, Nsukka, Enugu State, Nigeria
* E-mail of the corresponding author: cogbanje@gmail.com

Abstract
The study evaluated the factors that affected off-farm diversification among small-scale farmers in North Central region of Nigeria. Multistage sampling technique was used to select 180 respondents. The primary data obtained with the aid of standard questionnaire were analysed using discriminant function analysis. The dependent variable, off-farm work typology, comprised three groups namely, agricultural wage employment, non-agricultural wage employment, and self employment. Based on factor loading, the strongest predictor was fund for farm investment (0.654) while the weakest predictor was crop failure (0.359). The canonical correlation of 0.572 implied that 32.72% of the variation in off-farm work typology was explained by the discriminators included in the model. The chi-square statistic (77.89) of Wilk's lambda was statistically significant ($p<0.01$), implying that discriminant function was appropriate and significant. Self-employment category had the best classification (88.3%), while agricultural wage had the poorest classification (0.0%). Although, the F-statistic of the Box's M test (7.07) was significant and the null hypothesis accepted that the covariance matrices were not equivalent, the significance was disregarded on the grounds that the sample size was large and the number of groups in the dependent variable was more than two. It was concluded that small-scale farmers in the study area embarked on enterprise diversification in order to generate funds for farm investment, although there was a gradual drift from the core agricultural production sector to self-employment. Therefore, government should encourage farm investment by subsidising farm input, improving farm produce price and farm credit delivery. This would, among other things, check the adverse impact of dual farm structure on food production.
Keywords: Nigeria, small-scale farmers, diversification, off-farm work typology, discriminant function analysis, predictor.

Introduction

In sub-Saharan Africa, agriculture occupies a prominent position in national economies because the sector serves as a key driver of growth, employment generation, wealth creation, food production, raw material supply, and poverty reduction (Ekpo & Olaniyi, 1995; Diaz-Bonilla & Gulati, 2003; Lawanson, 2005; Wankoye, 2008). Ajakaiye (1993), National Bureau of Statistics (2007) and Matthew (2008) attested to the potentials and indispensable roles of agriculture in Nigeria's economy. The recognition of the role of agriculture informed the decisions of the Federal Government and donor and foreign agencies to marshal numerous interventions to the sector (Oyeyinka, Arowolo & Ayinde, 2012). This is because the need to increase farm income and agricultural productivity among small-scale farmers is *sine qua non*, if the farmers must maintain their role of feeding the nation.

Off-farm income is that portion of household income which is obtained off the farm. Off-farm income doubles as risk minimisation and household income stabilisation strategies. In the United States, for instance, off-farm income accounted for over 90 percent of farm operators' household income (Babcock, Hart, Adams & Westhoff, 2000; Briggeman, 2011). Blank, Erickson, Nehring and Hallahan (2009) and Briggeman (2011) asserted that several farms in the United States of America could not boast of favourable leverage ratio without off-farm income. In a developing country like Nigeria, where agriculture has been relegated, and further worsened by flagrant diversion of agricultural intervention funds to unintended beneficiaries (Idachaba, 1993), off-farm activities deserve no less attention. Besides, Babatunde (2008) found that off-farm income supplemented and boosted farm and total household incomes. Reardon (1997) held that households are pulled into off-farm activities when returns to off-farm employment are higher and less risky than in agriculture. On the other hand, when farming is less profitable and more risky due to population growth and market failures, many households are pushed into non-farm activities. The failure of these interventions to make sustainable impact on the sector has precipitated dual farm structure where small-scale farmers seek farm financial relief from the off-farm sector of rural economy.

Off-farm engagement is generally disaggregated into three components. These are agricultural wage employment (AWE), involving labour supply to other farms, non-agricultural wage employment (NAWE), including both

formal and informal non-farm activities, and self-employment (SE) such as own businesses (Babatunde, Olagunju, Fakayode & Adejobi, 2010; Ibekwe *et al.*, 2010). De Janvry and Sadoulet (2001) and Ruben and Van den Berg (2001) have shown that farmers resorted to these sources to boost farm capital and investment. Off-farm work implies that the farmer allocates his endowed time among farm work, market, and leisure hours. Hence, off-farm work is seen to divert critical resources away from the farm sector, thereby leading to dual farm structure. Studies have shown that off-farm work participation is the first step out of farming (Glauben, Tietje & Weiss, 2003; O'Brien & Hennessy, 2005).

A group of literature has shown that farmers' resort to sourcing credit from financial intermediaries has not brought the much anticipated farm capital relief (Folawewo & Osinubi, 2006; IFPRI, 2007; Ogunmuyiwa & Ekone, 2010; Obike, Ukoha & Nwajiuba, 2011). Other studies have reported the inadequacy of farm income and high prevalence of poverty among small-scale farmers resulting in their inability to meaningfully invest in farm business (Lambert & Bayda, 2005; Kwon, Orazem & Otto, 2006). Consequently, current research in agricultural finance has beamed its searchlight on off-farm diversification embarked upon by farmers as an alternative and sustainable source of farm capital. It is, thus, expedient to provide empirical content on the role of off-farm employment in farm capital accumulation as well as dual farm structure.

Ahituv and Kimhi (2002) examined the role of heterogeneity and state dependence of off-farm work and capital accumulation decisions of farmers over the life-cycle. Babatunde *et al.* (2010) analysed the determinants of participation in off-farm employment among small-holder farming households in Kwara State. Ibekwe *et al.* (2010) evaluated the determinants of non-farm income among farm households in southeast Nigeria. These studies focused more on socioeconomic characteristics rather than those of the prevailing business environment. No known study has identified the factors that affect off-farm diversification in the entire North Central Nigeria using discriminant function analysis, neither has any researcher examined the implication of off-farm work for the emerging dual farm structure. These are the research gaps that this study was designed to fill.

The goal of the discriminant function analysis is to combine the variable scores in such a way that a single composite variable, the discriminant score, is produced. Discriminant function analysis involves the determination of a linear equation that would predict which group the case belongs to, or the group which respondents are mostly inclined to. The specific objective of the study was to identify the factors that influence enterprise diversification among small-scale farmers. It was hypothesised that the variance co-variance matrices were not equivalent.

Methodology

The study was conducted in the North Central geo-political region of 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. 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 (Food and Agriculture Organisation (FAO), 2002; National Bureau of Statistics, 2007). Majority of the populace is in agriculture, with farm size ranging from 0.4 to 4.0 ha (FAO, 2002; National Food Reserve Agency, 2008).

Multistage sampling technique was used to select respondents for the study. In the first stage, three states namely, Benue, Kogi and Niger, were selected randomly from the region. In the second stage, two agricultural zones were randomly selected from each state, making a total of six agricultural zones. In the third stage, two Local Government Areas (LGAs) were randomly selected from each agricultural zone, amounting to 12 LGAs. In the fourth stage, three farming communities were randomly selected from each LGA, amounting to 36 farming communities. Finally, five small-scale farmers in off-farm work were randomly selected from each farming community. Thus, the sample size for the study was 180. Data for the study were collected from primary source with the aid of structured and pretested questionnaire designed in way to generate data that would adequately achieve the objectives and hypotheses of the study.

Empirical formulation of multiple discriminant function analysis

Discriminant function analysis was used to estimate the weighted linear combination of categorical variables that influenced or discriminated against enterprise diversification among small-scale farmers in the study area. The grouping variable was off-farm work main typology. The multiple discriminant function analysis was specified as follows:

$$D = v_1X_1 + v_2X_2 + \cdots + v_{22}X_{22} + a$$

Where:

D = discriminate function; the groups were AWE, NAWE, and SE, otherwise denoted as off-farm work typology,

v = discriminant coefficient or weight for the variable,

X_1 = respondent's score for fund for farm investment,
X_2 = respondent's score for fund for household needs,
X_3 = respondent's score for hospital,
X_4 = respondent's score for pipe borne water,
X_5 = respondent's score for inadequate farm land,
X_6 = respondent's score for drought,
X_7 = respondent's score for crop failure,
X_8 = respondent's score for electricity,
X_9 = respondent's score for tarred road,
X_{10} = respondent's score for market,
X_{11} = respondent's score for increased household,
X_{12} = respondent's score for inefficient input market,
X_{13} = respondent's score for unstable farm income,
X_{14} = respondent's score for poor produce price,
X_{15} = respondent's score for risky farm production,
X_{16} = respondent's score for farmland ownership,
X_{17} = respondent's score for government payment,
X_{18} = respondent's score for credit market,
X_{19} = respondent's score for inadequate farm income,
X_{20} = respondent's score for higher off-farm income,
X_{21} = respondent's score for main occupation,
X_{22} = respondent's score for shares received, and
a = constant.

Results and Discussion

Group Statistics of Factors affecting Enterprise Diversification

The means and standard deviations of the independent variables in the group statistics presented in table 1 indicated that large differences existed between the variables. This implied that the variables were good discriminators. Variables with the highest mean in the three components of off-farm work included higher off-farm income, absence of government payment and subsidy of farm inputs, risky farm production, poor produce price, unstable and inadequate farm income, inefficient credit market, farmland ownership, and inefficient input market. These were the main reasons that attracted farmers to off-farm work.

These variables have support in various literature. For instance, Harris, Blank, Erickson and Hallahan (2010) contended that off-farm income contributed to reducing the riskiness of the income stream facing the farm household. In addition, Reardon (1997) and Ellis (1998) have noted that income diversification was induced by declining farm income and the need to insure against agricultural production and market risks. The distress-push diversification (farm becoming less profitable and more risky) and the demand-pull diversification (higher and less risky returns to off-farm employment) articulated by Babatunde *et al.* (2010) were also confirmed by this finding.

Table 1: Group statistics of factors affecting enterprise diversification

Discriminators of off-farm work typology	Group Statistics	
	Mean	Standard Deviation
Fund for farm investment	4.32	2.149
Fund for household needs	5.65	2.152
Hospital	5.62	1.969
Pipe borne water	6.62	1.969
Inadequate farm land	7.62	1.969
Drought	9.96	5.267
Crop failure	9.81	4.675
Electricity	5.76	3.939
Tarred road	6.76	3.939
Market	7.76	3.939
Increased household size	8.76	3.939
Inefficient input market	14.62*	6.093
Unstable farm income	16.84*	3.447
Poor produce price	17.03*	2.462
Risky farm production	17.22*	1.477
Farmland ownership	15.67*	4.220
Government payment	17.59*	0.492
Credit market	16.76*	3.939
Inadequate farm income	17.76*	3.939
Higher off-farm income	18.76*	3.939
Main occupation	9.52	10.340
Shares received	12.62	2.025

* best discriminators

Source: Computed from field survey data, 2013

The test of equality of group means in table 2 provided strong statistical evidence of significant differences between means among the components of off-farm work. All the variables produced significant F-statistic with the highest f-statistic coming from fund for farm investment.

Table 2: Tests of equality of group means

	Wilks' Lambda	F-statistic	Discriminant Function1	Discriminant Function2	Significance
Fund for farm investment	0.824	18.892	2	177	0.000
Fund for household needs	0.857	14.729	2	177	0.000
Hospital	0.848	15.817	2	177	0.000
Pipe borne water	0.848	15.817	2	177	0.000
Inadequate farm land	0.848	15.817	2	177	0.000
Drought	0.904	9.446	2	177	0.000
Crop failure	0.911	8.695	2	177	0.000
Electricity	0.848	15.817	2	177	0.000
Tarred road	0.848	15.817	2	177	0.000
Market	0.848	15.817	2	177	0.000
Increased household	0.848	15.817	2	177	0.000
Inefficient input market	0.896	10.323	2	177	0.000
Unstable farm income	0.848	15.817	2	177	0.000
Poor produce price	0.848	15.817	2	177	0.000
Risky farm production	0.848	15.817	2	177	0.000
Farmland ownership	0.965	3.187	2	177	0.044
Government payment	0.848	15.817	2	177	0.000
Credit market	0.848	15.817	2	177	0.000
Inadequate farm income	0.848	15.817	2	177	0.000
Higher off-farm income	0.848	15.817	2	177	0.000
Main occupation	0.848	15.817	2	177	0.000
Shares received	0.973	2.502	2	177	0.085

Source: Computed from field survey data, 2013

Summary of Canonical Discriminant Functions

Eigenvalues

Squaring the canonical correlation (0.572) in table 3 suggested that 32.72% of the variation in the grouping variable was explained – whether a respondent belonged to either of the off-farm work typology. The low canonical correlation was attributed to the obvious overlapping of the groups. In table 4, the chi-square statistic (77.89) of Wilks' lambda was significant ($p<0.01$), implying that the discriminant function was significant and appropriate for the data.

Table 3: Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	0.486*	90.7	90.7	0.572
2	0.050*	9.3	100.0	0.218

*First 2 canonical discriminant functions were used in the analysis

Source: Computed from field survey data, 2013

Table 4: Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Significance
1 through 2	0.641	77.89	10	0.000

Source: Computed from field survey data, 2013

The structure matrix in table 5 indicated the relative importance of the predictors as it displayed the correlations of each variable with each discriminate function, resulting in discriminant loadings. With 0.30 as the cut-off point, and using function one, predictors which were not loaded on the discriminant function, were shares received (0.021) and farmland ownership (0.235). These predictors were, therefore, not associated with off-farm work. On the other hand, the strongest predictor was fund for farm investment (0.654) while the weakest predictors were crop failure (0.359), drought (0.398) and inefficient input market (0.478). This highest discriminant loading is in line with Harris *et al.* (2010) that the presence of off-farm income relaxed the budget

constraints in the farm household. Farm households that depended solely on farm income often used a larger proportion of farm profit to satisfy consumption demands thereby reducing capital available for farm investment. Reardon (1997) and Ji, Zhong and Yu (2011) have noted that off-farm income increased farm capital accumulation if the farm family was subjected to borrowing constraints. Obike *et al.* (2011) observed that borrowing constraint was prevalent among small-scale farmers in Nigeria.

Table 5: Structure matrix

S/N	Predictors	Function	
		1	2
i	Fund for farm investment	-0.654*	0.334
ii	Fund for household needs	-0.585*	0.024
iii	Inefficient input market	0.478*	-0.335
iv	Crop failure	-0.359*	0.846
v	Drought	-0.398*	0.772
vi	Risky farm production	-0.554*	0.766
vii	Inadequate farm income	0.554*	-0.766
viii	Tarred road	0.554*	-0.766
ix	Market	0.554*	-0.766
x	Credit market	0.554*	-0.766
xi	Poor produce price	-0.554*	0.766
xii	Electricity	0.554*	-0.766
xiii	Increased household size	0.554*	-0.766
xiv	Government payment	0.554*	-0.766
xv	Unstable farm income	-0.554*	0.766
xvi	Inadequate farm land	-0.554*	0.766
xvii	Pipe borne water	-0.554*	0.766
xviii	Higher off-farm income	0.554*	-0.766
xix	Main occupation	-0.554*	0.766
xx	Hospital	-0.554*	0.766
xxi	Shares received	0.021	-0.750
xxii	Farmland ownership	0.235	-0.430

* predictor of enterprise diversification

Source: Computed from field survey data, 2013

Off-farm work Classification Results

The cross-validated section of off-farm work classification in table 6 showed that SE had the best accuracy (88.3%). This indicated the group of off-farm work which majority of farmers were mostly inclined to, *ceteris paribus*. The next most likely group that was attractive to the farmers was NAWE, with classification of 67.4%. The poor classification of AWE indicated further drift from core agricultural wage labour supply as indicated by Harris *et al.* (2010). Thus, the emerging dual farm structure was confirmed to be prevalent among the small-scale farmers. This result is a further proof of the true state dependence of Ahituv and Kimhi (2002) that those who have worked off-farm earlier have higher probability of commuting to more intense level of off-farm work. Off-farm work, as noted by O'Brien and Hennessey (2005) is the first step out of farming, especially for marginal producers.

Table 6: Off-farm work typology classification results[b,c]

			Predicted Group Membership			
		Major Component of off-farm work	AWE	NAWE	SE	Total
Original	Count	AWE	0	26	34	60
		NAWE	0	34	9	43
		SE	0	9	68	77
	%	AWE	.0	43.3	56.7	100.0
		NAWE	.0	79.1	20.9	100.0
		SE	.0	11.7	88.3	100.0
Cross-validated	Count	AWE	0	26	34	60
		NAWE	0	29	14	43
		SE	0	9	68	77
	%	AWE	0.0***	43.3	56.7	100.0
		NAWE	0.0	67.4**	32.6	100.0
		SE	0.0	11.7	88.3*	100.0

Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b. 56.7% of original grouped cases correctly classified.

c. 53.9% of cross-validated grouped cases correctly classified.

* best classified group ** averagely classified group *** poorly classified group

Source: Computed from field survey data, 2013

Test of equality of covariance matrices – the hypothesis

Following the assumption of discriminant function analysis that the variance-co-variance matrices are equivalent, the log determinants and Box's M test were used to test the null hypothesis that the covariance matrices did not differ among the groups – typology. As shown in table 7, the log determinants appeared similar to one another. However, the Box's M test (110.549) in table 8, with F-statistic (7.07), was significant ($p<0.01$). The implication was that the covariance matrices were not equivalent. Nevertheless, the significance of Box's M was disregarded since the sample was large and the dependent variable had more than two groups. The significance of Box's M further implied that the group with the least log determinant might not be considered so important for further analysis. In this study, the group with the least log determinant was AWE (4.12). The poor classification of AWE indicated decreasing labour availability in the farm sector, a further proof of drift from the core farm production sector.

Table 7: Log determinants

Component of off-farm work - major	Rank	Log Determinant
Agricultural wage employment	5	4.12
Non-agricultural wage employment	4	5.995
Self employment	5	5.999
Pooled within-groups	5	5.787

The ranks and natural logarithms of determinants are those of the group covariance matrices.

Source: Computed from field survey data, 2013

Table 8 Box's M test results table

Box's M		110.549
F	Approx.	7.07
	df1	15
	df2	64,400
	Significance	0.000

Tests of null hypothesis of equal population covariance matrices.
Source: Computed from field survey data, 2013

Conclusion and Recommendations

The factors that pushed or pulled farmers into off-farm work in the study were higher off-farm income, absence of government payment and lack of farm input subsidy, risky farm production, poor produce price, unstable and inadequate farm income, inefficient credit market, farmland ownership, and inefficient input market. The strongest predictor of off-farm diversification in the study area was the need to generate funds for farm investment. Small-scale farmers in the study area drifted away from core agricultural production towards non-farm activities. Unless these farmers in off-farm work plough substantial proportion of their off-farm work proceeds back into the farm sector as originally intended, the emerging dual farm structure would have adverse effect on food production.

It was recommended that the government should subsidise farm input; put modalities in place to improve farm produce price; improve farm credit delivery; and ensure efficient input market. These would improve farm investment the need for which pulled farmers away into off-farm work. The measure will, also, keep small-scale farmers back on the farm to sustain food production for the populace.

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