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Distributional effect of income on rural farm household welfarein Nigeria: Identifying knowledge gaps and policy options

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Abstract: *This paper investigates the distributional effect of income among rural farm households in Nigeria.A quantile regression approach was applied on cross-section data from a nationally representative data. Ordinary least square was also used for comparison purposes. Results show that household size, asset ownership, farm size, extension services and access to credit were the most important factors explaining income distribution across quantiles but with varying magnitude.Additionally, across methods of estimation, assets ownership, farm size, extension service and household size were consistent variables that influenced farm household income. We found that factors that determines income distribution among farm households was different suggesting covariates are not constant across quantiles. This paper puts forward relevant policy options suitable for improved household livelihood.*

Keywords*: Farm household, Income, Nigeria, Quantile regression, Rural*

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I. Introduction

With increased efforts in programmes and policy tools to improve the livelihood of rural households, fluctuating income level still persists which often tends to poor standard of living. Income as a source of livelihood is most crucial to household wellbeing and ithas been identified as a panacea in actualizing many developmental goals such as poverty reduction, food and nutrition security [1]. Also sustainable income sources translate to better livelihood outcomes which is fundamental to economic and social development of a nation [2]. Therefore, steady income sources guarantee sustainable agricultural productivity necessary to meet increasing demand for food and other agricultural products, as a result of population growth and rising urbanization [3]. Although, household welfare is dependent on real income but its variation especially within rural households could indicate different levels of welfare in addition to other socioeconomic variables.As such, it is expected that increased income would improve nutritional status of farm households. However, increased income often faced with competing priorities such as access to basic public services, increased cost of farm inputs (seeds, fertilisers, pesticides etc.) further constraints realised farm earnings. Therefore, increased purchasing power is more likely to lead to improved welfare outcomes where these shocks are relatively low ([4], [5]). As such, relevant strategies to improve provision of rural infrastructure and access to productive resources are key elements to better rural livelihood [2]. Thus, information on factors that influence farm income is of policy relevance forimproving welfare of farm household.

As farming and its related activities often constitute the major source of income, there are shortcomings that hinders farm households in participating in high value global food systems.Critical factors in supply chains such as risk in production failure, poor market network, post-harvest losses lower level of productivity which can result in income smoothing ([6], [7]). Also most government policies geared towards sustainable farm livelihood income are ineffective as a result of non-inclusiveness of farmers in implementation process coupled with inconsistent programmes such as credit schemes, inputs subsidy among others [8]. As reported by [9], limited income sources attributed to smallholder farmers, especially in Africa, tends to limit them in self-financing of improved farm inputs to produce enough food and cash crops to meet their household food and income security requirements. Also, inadequate manpower as a result of loss of labour to rural urban migration leaving the aged to farm coupled with peasant and poorly endowed and productive resources [10]. These further pushed households into poverty and persistent food insecurity, therefore it becomes necessary to identify factors along income quantile in order to inculcate these variables into policies that will help improve income level and subsequently improved welfare.

Due to high variability inherent in income, determining variation in farm household income along different quantiles is essential for informed policy strategies. Some empirical studies ([11], [12], [13], [14], [15], [16], [17], [18], [19]) relied on statistical analyses such as sample means, ordinary least square in explaining average effects of farm income. Although, these statistical tools are useful and relevant, however, estimation by the mean effect may not adequately characterize the underlying relations among variables [20].Therefore, the

need for more robust method of estimation that better reveals the underlying mechanism associated to rural farm income; this is the relevance of this paper. In this regard, quantile regression was used to examine determinants of income of farm household as it maintains a modelling advantage over linear regression with non-normally distributed data and for estimating dependent variable with high variation. However, some studies in this line included the works of [21], [22], [23] which combined both methods (multiple regression and quantile regression) to show the similarities in process as well as to identify distinct features of quantile regression. This method further helps to check if the interrelationship between income and its determinants are constant across income distribution [24].

Furthermore, important implications could be drawn from distributional effect of farm household income in terms of their food security status and level of agricultural productivity. As mentioned previously, quite a number of studies focused majorly on the determinants of farm income, however, there are still gaps in the literature on effect of farm income on household welfare at different income levels.Therefore, understanding the ways in which agricultural income especially among rural farm households can be leveraged to enhance livelihood status is most essential. This posits sound knowledge necessary to design policy options targeting farm households at different income distribution, as agriculture is the main source of livelihood in Nigeria. Also sustainable farm incomecan influence economic wellbeing and offer insights into the growth prospect of agriculture in Nigeria' s economy.This paper is set within a framework of identifying determinants of income distribution within rural farm households in Nigeria and its impacts on household livelihood outcomes towards productivity and higher wellbeing. These factors can be integrated into agricultural policy interventions which subsequently tends to increase rural household welfare through improve nutrient intake and nutritional outcomes.

II. Methods

2.1 Data

The General Household Survey (GHS-Panel) Wave 3 fielded by the National Bureau of Statistics in 2015-2016 was used for this paper. The survey was carried out to gather panel data on household characteristics, welfare and their agricultural activities. The survey was the result of the partnership established between the Federal Ministry of Agriculture and Rural Development (FMARD), the National Food Reserve Agency (NFRA), the Bill and Melinda Gates Foundation (BMGF) and the World Bank (WB) [25]. Under this partnership, agricultural and household data was formulated in a pattern that gives room for the examination of agriculture's role in household welfare. The dataset for rural household was well suited for this paper given the high dependence of the household on agricultural activities in the country which further provides vital information on the rural households such as human capital, economic activities and access to services and resources. A total of 2,269 was extracted from the pooled dataset which represented rural farm households in Nigeria. Descriptive statistics was used to analysed household socioeconomic characteristics, agricultural activities as well as expenditures on food and non-food.

2.2Empirical Model

2.2.1 Quantile Regression Model

Standard linear regression model analyses the average relationship (mean) of a continuous response variable as a linear function of a set of independent variables,E(Y/X) [26]. The relation of X with Y is estimated by minimizing the squared difference between the predicted value of Y and the observed value of Y (the sum of the squared error) and the result of the prediction equation can be represented by a single line through a scatterplot of points [20]. This estimation gives only a partial overview of the relationship, in this regard, the regression mean approach may not be appropriate in explicitly dealing with extreme values and outliers in the distribution of the dependent variable. Since we are interested in describing the relationship at different points in the conditional distribution of Y, we employed a quantile regression model to examine the determinants of farm household income at different points of income distribution. Quantile regression as introduced by [27] describes quantiles of the distribution of a response variable as a function of other observed covariates. This model helps to pre-define any positions of the distribution according to their specific analyses [28]. The different responses may be interpreted as differences in the response of the dependent variable to changes in the regressor at various points in the distribution of the dependent variable [26].Therefore, estimates from quantile-specific effects of farm income distribution are expected to differ due to variations in agricultural and socioeconomic characteristics of household [21].

Implicitly, QR can be specified as:

$$Q\theta(Y|X) = X'\beta\theta \quad (1)$$

where *Y*denotes the farm household income as a function of a set of independent variables, *X* within the θth quantile of the outcome variable,*Y*. The special feature of the quantile regression approach is that the set of coefficients of the independent variables, $\beta\theta$ can differ across quantiles. However, the estimator $\beta\theta$ of the quantile regression is obtained by minimizing the objective function, given as:

$$Q(\beta\theta)=\Sigma\theta|yi-xi'\beta\theta|Ni:\ yi\geq xi'\beta+\Sigma(1-\theta)|yi-xi'\beta\theta|Ni:yi<xi'\beta \quad (2)$$

via Simplex method. Also, the model can be rewritten as follows:

$$q(Yi) = ßqXi + eqi \quad (3)$$

where *q* is a specified quantile of total household income (*Yi)* with median regression denoted as *q*= 0.5

$ßq = [ß_{q1}, ß_{q2}, \dots ß_{qj}]$ is the vector of parameters to estimate,$Xi = [X_{i1}, X_{i2}, \dots X_{ij}]$ is the vector of household characteristics described in Table 1 and e*qi* is a random disturbance.

This method presents a more complete statistical analysis of the stochastic relationships among random variables. Due to unequal variations associated withfarm household income, there is need for more than a single slope (rate of change) process. Thus, quantile regression (QR) generates estimates with multiple rates of change (slopes) along response variable, therefore, providing more complete picture of the relationship between variables often overlooked by other regression methods. Also the model uses the entire sample to estimate each quantile hence no problem of sample bias selection [21]. As a result of the equivariance property of QR, marginal effects are estimated based on the underlying dependent variable [26]. From this, the coefficient of X in the θth quantile for marginal effect can be expressed as the marginal change (relative to the value of the θth quantile of the dependent variable) due to a one unit change in X, as θ can be specified as any value between 0 and 1 [28]. Using StataQreg, we considered a quantile regression at the 10th, 25th, 50th, 75th and 90th level with bootstrap standard errors on the estimated parameters with 100 replications.

III. Result and Discussion

The summary statistics presented in Table 1 revealed that more than three quarter of household heads are male (89%), married (86%) and with an average age of about 53 years. The average household size was about 8 persons while about three quarters of household heads were educated. There wasan evidence of low income diversification, as about 3% of household heads engaged in other income generating activities. This suggestslow level of risk averse among rural household which often tends to increase their vulnerability. With respect to household assets and agricultural tools, rate of ownership was about 0.36 and 0.34, respectively and on the average, household heads possessed about one hectare of land. Less than a quarter of the household heads had access to credit while about 3% of them received remittances from outside sources. Also, about 3% of households heads have access to extension services which suggests low level of information dissemination probably on adoption of improved technologies and high value addition strategies necessary for sustainable farm income.

Table 1:Summary statistics of variable usedin the model

Variables	Description	Mean values	Standard deviation
Sex	Sex of household head (1= male, 0= female)	0.89	0.30
Age	Age of household head in years	53.33	14.00
Married	Marital status (1 = married, 0 = otherwise)	0.86	0.35
Household size	Total number of persons living in the household	7.67	3.17
Educational status	Education level of household head (1= formal, 0 = otherwise	0.83	0.31
Other income source	Household head generate income from other sources (1= yes, 0= otherwise)	0.03	0.16
Asset ownership	Ownership of household asset (1= yes, 0 = otherwise)	0.36	0.26
Access to credit	Household head access to credit (1= yes, 0 = otherwise)	0.18	0.38
Remittance	Access to remittance (1=yes, 0 = otherwise)	0.03	0.17
Agricultural tools/machine	Rate of ownership of agricultural tools/ machine (1 = yes; 0= otherwise)	0.34	0.23
Farm size	Total farm size in hectares	1.02	1.38
Access to extension service	Household head access to extension services (1 = yes, 0= otherwise)	0.03	0.09

3.1 Estimates of Quantile regression

Quantile estimates presented in Table 2 shows that the model was well fitted as evident in the diagnostics results. The Pseudo R^2 value, a measure of goodness of fit ranging from 0.14 to 0.19explains income distribution for households in the higher quantiles better than those in lower quantiles [21]. Results further shows that covariates were not constant across the income distribution when compared with OLS estimates, hence the appropriateness of the model used. From the OLS estimates, marital status, household size, tertiary education, access to credit, ownership of asset, other income source, ownership of agricultural tools, access to extension service positively influenced farm income while size of farm land negatively influences it. Quantile results are quite similar to those of OLS especially at the median regression (50^{th} quantile) as shown in Table 2. However, there was an indication of significant differences across income distribution. Being in male headed household positively increased farm income as they tend to have more access to productive resources than women due to socio cultural values and norms. This could be the reason why female headed households are more prone to higher risk of malnutrition, food insecurity and poor welfare status. Female farmers often face a number of constraints in accessing agricultural inputs, services and markets which hinders them to rely solely on agricultural production as a pathway out of poverty as reported by [29]. Thus, policy measures toward addressing gender inequality will further generate multiple benefits in terms of productivity, food security and poverty alleviation.

However, it was observed that age of household head was found to be positive and significant only at the 25^{th} quantilewhile age squared negatively influence farm income. This explains lifecycle hypothesis which implies that as age increases, farm income will increase, but as household heads get older,its effect on income would rise at a declining rate. Therefore, this calls for policy options geared towards youth involvement in farming, as most agricultural activities are left in the hands of the aged due to rural urban migration. Also marital status had significant relationship on farm income only at quantiles below and above the median regression. The effect of household size on farm income differs across the quantile as estimates were found to be positive and highly significant in both regressions but with varying magnitude.As it is expected, that household size often determines the extent of labour available,however, its impact on livelihood might be detrimental as larger household size tends to negatively affect welfare in terms of consumption of diverse foods rich in micronutrient.Furthermore, educational attainment had positive and significant effect on farm income at 25, 50 and 75th quantile, corroborating the works of [22] and [23]. Therefore, higher educational status among rural farm households tends to improve the extent to which technological improvements are adopted and also effective use of productive resources which would subsequently increase farm earnings. A positive and significant relationship was found with respect to asset ownership which increases across quantiles. Contrary to expectation, access to credit by household heads reduces farm income at 25th,50th and 75th quantile. This could be as a result of untimely disbursement of loan, default in repayment terms, collateral issues and bureaucracy in credit schemes. However, the effect was stronger at lower quantiles which explains the importance of credit accessibility in improving farming activities among household heads especially those with low level of income.

Being engaged in other income earning activities by heads of household positively influence farm income at higher quantiles (75th and 90th quantiles). This suggests that the sensitivity of farm income to changes in other income sources is rather tied up at higher levels of income distribution. This, therefore, implies that participation in other income generating activities tends to increase income accrued to the family and translates to better livelihood outcomes [31]. This is consistent with [30] that diversification has positive effects on household incomes, consumption and nutrition which is of interest to policy makers because of itspotential effect on poverty reduction and economic growth.Also, the mean effect of other income source from OLS regression was also significant, however, quantile estimates further explain the distribution and category of house heads who engaged in income diversification.Ownership of agricultural assets positively and significantly increases income at higher quantile which suggestsavailability and timely use of these assets tends to improve incomeas suggested by [19] and [23].We observed that the size of farm land influences farm income but with varying signs and magnitude in both regressions. Contrary to expectation, farm size negatively influences income growth especially at lower quantile. This probably could be as a result of fragmented lands, land grabbing, poor resource endowment attributed to farm households which often results in low yield. However, at higher quantiles, effect of farm size was positive and significantly influence farm income. With respect to access to extension services, it was significant and positively increases farm household income across the quantile. The implication of this is that extension services delivery of improved varieties, market information will help farmers to increase productivity as well as their welfare. This calls for policy tools geared towards capacity building of extension officers through training, provision of logistics as well as incentives. This is expected to result in provision of efficient extension services delivery to farm households thereby increasing farm productivity.

Table 2: Parameter estimates of Quantile regression (QR) and Ordinary least square (OLS)

Variables	OLS	Quantile									
		0.10	ME	0.25	ME	0.50	ME	0.75	ME	0.90	ME
Sex	-0.0693	-0.0041	-7.62	-0.0565	-105.67	-0.0519	-97.07	0.2053**	384.05	-0.1259	-235.63
	(0.0632)	(0.0596)		(.0564)		(0.0703)		(0.0879)		(0.0885)	
Age	1.2111	-0.0760	-142.27	2.5946**	4854.64	1.9111	3575.75	-0.3221	-602.59	-0.4187	-783.40
	(0.9980)	(1.0657)		(1.2190)		(1.8186)		(1.3249)		(2.0774)	
Age squared	-0.1779	0.0001	0.09	-0.3505**	-655.95	-0.2621	-490.36	0.0093	17.34	0.0296	55.35
	(0.1276)	(0.1388)		(0.1560)		(0.2325)		(0.1671)		(0.2619)	
Married	0.1136**	0.0286	53.55	0.1081 *	202.18	0.1016	190.00	0.1654***	309.38	0.1785	334.01
	(0.0554)	(0.0554)		(0.0575)		(0.0705)		(0.0656)		(0.0689)	
Household size	0.0267***	0.0175***	32.68	0.0291***	54.48	0.0303 ***	56.77	0.0285***	53.29	0.0322***	60.15
	(0.0041)	(0.0061)		(0.0055)		(0.0062)		(0.0060)		(0.0090)	
Educational level											
Primary	-0.0127	0.0141	26.47	0.0295	55.21	0.0193	36.07	-0.0295	-55.18	-0.0846	-158.19
	(0.0367)	(0.0432)		(0.0501)		(0.0437)		(0.0385)		(0.0532)	
Secondary	-0.0135	-0.0351	-65.64	-0.0466	-87.14	-0.0065	-12.14	0.0011	2.11	0.0089	16.65
	(0.0312)	(0.0377)		(0.0470)		(0.0390)		(0.0364)		(0.0562)	
Tertiary	0.1636***	0.1490	278.75	0.1784***	333.80	0.1516**	283.71	0.1794***	335.65	0.0841	157.41
	(0.0489)	(0.1084)		(0.0661)		(0.0641)		(0.0489)		(0.0788)	
Asset ownership	0.9210***	0.9363***	1751.77	0.9590***	1794.39	0.9833 ***	1839.74	0.9943***	1860.26	0.8889***	1663.20
	(0.0486)	(0.1082)		(0.0811)		(0.1001)		(0.0650)		(0.0900)	
Access to credit	0.0847***	-0.0538	-100.67	- 0.1375***	-257.37	-0.0970***	-181.60	-0.0573*	-107.18	-0.0743	-138.96
	(0.0288)	(0.0538)		(0.0386)		(0.0396)		(0.0322)		(0.0484)	
Remittance	-0.0056	0.0457	85.44	-0.0342	-64.16	-0.0158	-29. 49	-0.0027	-5.04	0.0203	38.05
	(0.0653)	(0.0991)		(.1215)		(0.1111)		(0.0804)		(0.0930)	
Other income source	0.1211*	-0.0002	-0.42	0.0272	50.94	-0.1013	-189.55	0.2046**	382.85	0.1787*	334.31
	(0.0719)	(0.1102)		(0.1596)		(0.1308)		(0.1060)		(0.1030)	
Agricultural tools/machine	0.1461***	0.0026	4.81	0.0318	59.67	0.1888*	353.19	0.3031	567.14	0.3141***	587.73
	(0.0518)	(0.0804)		(0.0841)		(0.1009)		(0.0722)		(0.0936)	
Farm size	-0.0576***	-0.0433***	-81.05	- 0.0602***	-112.75	-0.0577***	-107.92	0.0541***	101.15	0.0630***	117.87
	(0.0086)	(0.0129)		(0.0152)		(0.0128)		(0.0107)		(0.0132)	
Access to extension service	0.6648***	0.2742	513.06	0.6530 **	1221.77	0.8856***	1657.02	0.8882***	1661.78	0.8349***	1562.14
	(0.1217)	(0.2814)		(0.2686)		0.1927		(0.1977)		(0.2687)	
Constant	5.6165	7.3541	13759.62	2.7720	5186.45	4.5202	8457.47	9.6096***	17980.0	9.8586**	18445.8
	(1.9415)	(2.0679)		(2.3817)		(3.5062)		(2.6122)	3	(4.1613)	7
Number of observation	2269										
Adjusted R^2	0.2757										
Pseudo R^2		0.1392		0.1419		0.1489		0.1830		0.1893	

Figures in parentheses: Standard error. p values: *** 1%; ** 5%; * 10%. ME- Marginal effect

Considering the marginal effect across quantile distribution, we observed differences at the rate in which an infinitesimal change in explanatory variables influences farm income. With respect to household size, an additional member of household increases income but rather at a low rate. Although large household size is synonymous to rural areas especially for labour use. Based on the rate at which household income rises suggests large family size might not necessarily improve farm income and there could be tendency of food and nutrition insecurity. Thus, sensitization on keeping moderate family size is appropriate and policies geared towards farm mechanization will help boost income. In addition, result shows that marginal effect for extension services and asset ownership contributed largely to farm income. For instance, an extra access to extension services by household heads would increase significantly farm income across the quantile. Therefore, strategies toward research and development coupled with accessible linkages with extension agents is highly important as rapid changes are occurring in the food system.

IV. Conclusion and Policy Recommendation

This paper assessed factors that determines farm household income in rural Nigeria. Understanding the determinants of income at different quantiles of the distribution as evident from the results provide better information on how these variables can be integrated into policy options that will help to improve farm household livelihood. From the empirical findings, this paper puts forward that factors that determine income of farm households varies along income distribution. Across methods of estimation, assets ownership, farm size, extension service and household size were consistent variables that influenced farm household income. Thus, policy tools for rural development should revolve around propositions that would improve investment in household income. The multiplier effects of such policies would lower constraints to production, enhance food security status, extend economic base and maintain the attractiveness of living in rural areas. These strategies are essential as rapid changes and transitions in food systems increasingly call for effective and well targeted policy responses among farm households who produces the bulk of food.Also, more investment in agriculture

and agrifood systems, including increased spending on research and development is needed to enhance agricultural productivity and promote innovation for sustainable agriculture, rural prosperity and food security.

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