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Modelling Contract Farming Impact on Poultry Farm Income: Lessons from the Nigerian Anchor-Borrower Outgrowers' Programme

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Abstract: Contract farming was introduced in Nigeria to address the challenges faced by smallholder farming households in realising farming objectives. Therefore, this study examined the effectiveness of the Anchor-borrower Outgrowers' Programme in fulfilling one of its roles of increasing the net farm income of poultry farming households in Nigeria. A multistage sampling technique was used for data collection from the respondents. The endogenous switching regression model was used to estimate the impact of contract farming on the net farm income of farming households in Southwestern Nigeria. The findings from the first stage of the Endogenous Switching Regression Model revealed that age, major distribution outlet, off-farm income, transaction cost, flock size, and association membership determined farmers' participation in the poultry anchor-borrower outgrowers' scheme. The second stage further revealed the socioeconomic characteristics affecting the net income of beneficiaries and non-beneficiaries, including sales price, flock size, proximity to the urban center (Lagos), education qualification, off-farm income, and transaction cost. The result from the estimated average treatment effect (ATE) revealed that participation in anchor-borrower poultry contract farming had a positive influence on the net farm income of beneficiaries. Thus, evaluating and providing solutions to factors highlighted in this study that hinder participation in contract farming is important to ensuring more farmers enjoy the opportunities provided by contract farming. In this same vein, contract farming programmes in Nigeria should consider providing fixed inputs such as land and buildings through lease agreements, as this influences participation in the programme. In addition, older farmers should be encouraged to key into anchor-borrower poultry contract farming and refrain from viewing them as scam schemes akin to past programmes they engaged in over their extensive years of agricultural experience.

Keywords: Contract farming, net farm income, endogenous switching regression model, AIPWR model, average treatment effect

Introduction

The agricultural sector is a primary source of income and livelihood for many of Africa's population, as the sector employs about 70% of the total labour force, accounting for approximately 35% of the GDP in most African countries (Christiansen and Demery, 2018).

Africa has experienced significant growth in the agricultural sector, with an average growth rate of 0.73% per annum in agricultural productivity (Giller *et al.,* 2021; Myeki *et al.,* 2022). Despite this positive growth, the smallholder farmers who dominate the agricultural landscape in developing countries, including Nigeria,continue to experience a chronic cycle of poverty due to low income from farming activities (Aminu *et al.,* 2021; FAO, 2021). According to Wuyep and Rampedi (2018), the average household income among smallholder farmers in developing economies is only slightly above the minimum wage of ₦33,000 ($66.00 USD), with only 27% of these farmers living above the $2.50 USD daily poverty line. These conditions are largely due to challenges such as limited access to inputs and markets, high transaction costs, and inadequate production techniques (Aminu *et al.,* 2021; Mukaila *et al.,* 2021).

Recognising the detrimental impact of these challenges on farming households and the wider economy, the Nigerian government, alongside non-governmental organisations, has implemented various initiatives and programmes to support farmers. Of particular importance are outgrowers' programmes, structured as contract farming arrangements. These programmes provide a crucial institutional framework for agricultural financing, market linkage, and overall transformation and modernisation of farming activities in Nigeria (Omodara *et al*., 2023; Olomola, 2010).

Contract farming has emerged as a key strategy for transforming and industrialising agriculture in developing economies. It promotes collaboration among key stakeholders - including sponsors, agribusiness firms, and processors - who provide both in-kind and financial support to smallholder farmers (Otsuka *et al.,* 2016). It also represents a form of vertical market integration within agricultural commodity chains, aimed at improving household welfare, enhancing food security, increasing farm income, and promoting overall agricultural development (Omodara, 2023; Meemken and Bellemare, 2020). Though contract farming has a long history in both developed and developing countries, it has become increasingly prevalent in the latter, where it plays a vital role in integrating smallholder farmers into the market economy (Otsuka *et al.,* 2016).

Several studies (Liang *et al.,* 2023; Omodara *et al.,* 2023; Meemken and Bellemarem, 2020) have demostrated the importance of contract farming in improving access to labour, credits, technology, and markets for smallholder farmers. These studies also emphasise that the choice of contract model significantly affects how the programme is structured and managed. Five major models of contract farming exist: the centralised model, the nucleus estate model, the multipartite model, the informal model, and the intermediary model. Among these, the centralised and multipartite models are most commonly practised in Nigeria (Omodara *et al.,* 2023; Olomola, 2010). The centralised model involves firms contracting crop or livestock production to outgrowers under specific quality standards. For instance, the British American Tobacco Foundation, supported the Tobacco Growers' Programme by providing inputs such as tree seedlings (Olomola, 2010). The multipartite model involves multiple stakeholders - including public and private entities, and input suppliers - working with smallholder farmers. Programmes such as the Anchor-Borrowers Outgrowers' Scheme adopt this model across various states in Nigeria (Omodara *et al.,* 2023).

Contract farming is widely practised across major agricultural commodities in Nigeria including cotton, ginger, rice, soybean, tobacco, and poultry. While Several studies (Sanusi, 2017; Ayinde *et al.,* 2018; Badejo and Adekeye, 2018; Obih and Baiyegunhi, 2018; Okeke *et al.,* 2019) have explored the effect of anchor-borrower contract farming on the livelihood, income, and productivity of farmers, most of these research focus on crop production, neglecting the poultry and livestock sub-sector - despite their significance in Nigeria's agricultural economy.

The poultry sector, in particular, plays a critical role in generating income and sustaining livelihoods for Nigerian farming households. This is driven by strong demand for poultry products and a high level of meat consumption. Although Nigeria boasts the second-largest poultry industry in Africa, it still relies heavily on imports due to a supply deficit of

approximately 529,000 metric tonnes (Netherlands Enterprise Agency, 2020). Research by Erdaw and Bayene (2022) and Anosike *et al.* (2018) have identified factors contributing to this demand-supply gap, including high feed costs, limited access to credits, inadequate infrastructure, and poor market conditions. These constraints have led to the closure of many poultry farms and reduced the net farm income of existing poultry farmers (Erdaw and Bayene, 2022; Anosike *et al.,* 2018; Omodele *et al*., 2014; Omodele and Okere, 2014). Given the proven role of contract farming in improving farm income, evaluating the effectiveness of state-driven contract farming in Nigerian poultry industry remains both timely and necessary. In light of this background, this study investigates how participation in the Anchor-Borrower contract farming scheme affects the net farm income of poultry smallholder farmers in Southwestern Nigeria.

Methodology

Study Area

This study was carried out in the southwest geopolitical zone of Nigeria consisting of six states: Lagos, Ondo, Osun, Ogun, Oyo, and Ekiti. The region lies between longitude 3^0 31` and $6^0$ 11` East of the Greenwich Meridian and Latitude 6^0 21` and $8^0$ 37` North of the Equator, covering a total land area of 11,4271 km^2. It is bounded by Kwara and Kogi States in the North, Delta and Edo States in the East, Gulf of Guinea in the South, and Benin Republic in the West. As at 2006, the region accommodates approximately 27,581,992 peopl, predominantly Yoruba (NPC, 2006). The area is characterised by two climatic seasons, the wet season that occurs from April to October and the dry season that prevails from November to early March. It has a tropical climate, with average temperature range between 21^0C and 34^0C and a mean annual rainfall of 150 mm at its northern part to 3000 mm along the coast. Vegetation ranges from mangrove forest and freshwater swamp to lowland forest and derived Savannas, supporting a varieties of agricultural activites, inc;uding livestock rearing - particularly poultry, guinea fowl, duck, and turkey. Farming, trading, and artisanal work constitute the primary occupation in the region, with livestock production forming a key component of livelihood strategies. According to Netherlands Enterprise Agency (2020), Southwest Nigeria accounts for over one-third of all commercial poultry farms in Nigeria owing to the presence of commercial centres such as Ibadan, Lagos, and Abeokuta.

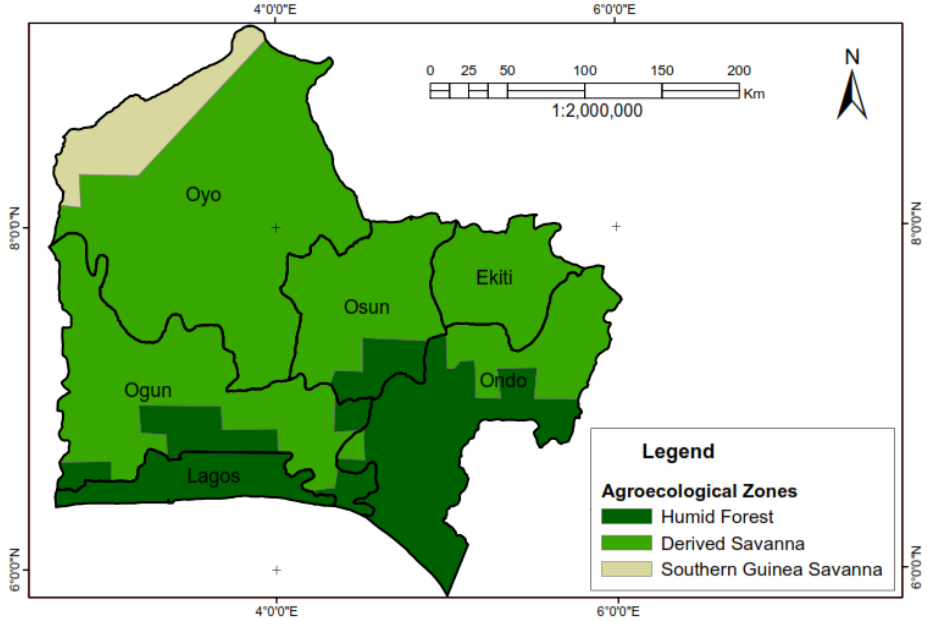

Figure 1: Map of southwestern Nigeria. Source: Google Map, 2022.

Sampling Procedure

This study adopts a multistage sampling technique. The first stage involved a purposive selection of two states that had participated in poultry contract farming in Southwest Nigeria for at least three years. State with less than 3-year of participation were exempted. Thus, Osun and Ogun States were selected. The second stage involved a purposive selection of all the local government areas in the two selected States that were involved in poultry contract farming. The third stage employed a purposive selection method to select the broiler farmers only. This is because only broiler farmers were targeted under the poultry outgrowers' programme in the study area. At the fourth stage, broiler farmers were stratified into subsistence, smallholder commercial, and large-scale commercial farmers in accordance with the criteria given by Pagani *et al.* (2008). At the fifth stage, these smallholder commercial farmers were stratified into beneficiaries and non-beneficiaries of anchor-borrower poultry outgrowers' programme (ABOP) . The list of all beneficiaries of ABOP, a specific type of contract farming in the selected states were then obtained from the Central Bank of Nigeria, totalling 652 broiler farmers for Ogun State and 320 farmers for Osun State. Using Yamane's (1967) formula, we calculated our sample size from the population of the farmers between the two states. This formula is suitable when he population is known and is expressed as

$$n = \frac{N}{1+N(e)^2} \quad \text{.....(1)}$$

where nnn is the sample size, NNN is the population size, and eee is the level of precision (set at 10%), the estimated sample sizes for Ogun and Osun States were 87 and 76 respectively. At the sixth stage, the beneficiaries were further divided into farmers that have benefited from ABOP for over 6 production cycles and those that have benefited for less than 6 cycles. Then, a random sampling technique was used to sample 75 farmers from the list of the farmers that have benefited for over 6 cycles in the selected LGA in the two selected States. The sample selected falls within the statistically acceptable range determined by the Yamane formula in our study and also ensures focused data collection on only farmers with adequate programme exposure.

For the non-beneficiaries, a snowball sampling technique was used to select 75 non-beneficiaries from the selected LGAs in each of the two States based on the concentration of broiler birds in the areas as presented by Adebisi *et al.* (2019).

The questionnaire used in this study was structured to collect data on contract farming participation requirements, farmers' socioeconomic characteristics, and their sales and returns. The validity and reliability of the questionnaire were assessed through a pilot test conducted with a small group of broiler farmers not part of the study sample. Based on the pre-test feedback, necessary adjustments were made to ensure the clarity and relevance of the questions before the actual study survey was conducted

Analytical Technique

Marginal effect of contract farming on sales volume and net farm Income

Endogenous Switching Regression Model (ESR) is a two-stage procedure with a selection and outcome equations. For the selection model, a probit model was specified to predict the probability of whether an individual household participated in the outgrowers' market (D=1) or spot market (D=0). This procedure then generates an additional variable called the inverse mill ratio that corrects for endogeneity in the dataset due to sample selection bias and specification error. We assumed that certain criteria, such as being a member of an association or having a specific livestock size and infrastructure, could influence the selection process and thus preselect participation in the ABOP programme. Then, the inverse mill ratio was added to other

explanatory variables in the outcome equation to explain variances to the continuous, non-zero dependent variable in regime two and nullify sample confoundness in the outcome equation.

The two-regimes procedures are explicitly and simultaneously specified as follows:

$$Y_{2i} = \beta_{i0} + \sum_{m=1}^{11} \beta_{im} lnx_{im} + \varepsilon_{im}, S(D_i = \alpha_{0i} + \sum_{n=1}^{17} \alpha_{in} \ln z_{in} + c_{in}) \ldots\ldots\ldots (2)$$

Where:
Y_2= net farm income (Naira)
x_1= Age (years)
x_2 =years of formal education (years)
x_3=major outlet of distribution (1=farm gate/individual contact, 2=local market retailing, 3=marketer/processors)
x_4= amount of off-farm income (Naira)
x_5= transaction cost (Naira)
x_6=access to credit (1=access, 0=otherwise)
x_7=sales price (Naira)
x_8= ownership of a vehicle (1=mobile, 0=not mobile)
x_9=average birds age at the market size (week)
x_{10} = flock size (bird count)
x_{11} = proximity to Lagos (1=yes, 0=no)
x_{10} = selectivity bias (inverse mill ratio)
S=selection command
Ln= natural log of

The use of some variables in our explanatory variables, which are not commonly included in the literature, such as the inclusion of transaction cost and proximity to Lagos, was based on the premise that these factors directly influence market access and income generation. We propose that further research could explore additional variables that may also contribute to the farmers' income, such as infrastructure quality or local policy support.

Treatment effect of ABOP on Net Farm Income (NFI)

ESR has been used to estimate the actual and expected outcome of a treatment on outcome variable (Lokshin and Sajaia, 2004). In this study, the expected outcome values for the beneficiaries and non-beneficiaries of anchor-borrower contract farming, Y_{io} and Y_{is} are given as

$$E(Y_{io}|D_i = 1) = X\beta_{io} - \sigma_{ioe}, \lambda_o \ldots\ldots (3)$$
$$E(Y_{is}|D_i = 0) = X\beta_{is} - \sigma_{ise}, \lambda_s \ldots\ldots (4)$$

Where,

Y_{io}, is the NFI by beneficiaries of anchor-borrower contract farming (ABOP) in the outgrowers' market;
Y_{is} is the NFI by non-beneficiaries of anchor-borrower contract farming (ABOP) in the spot market;
X_i is the vector of farm asset balance, production technology used, socio-economic variables of poultry farmers and market institutional factors such as transaction costs;
β_o and β_s are parameters for Outgrowers' and spot markets respectively;

$u_{io}$and u_{is} are error terms.

Unobserved farmers' characteristics may cause participants in contract farming to behave differently from average farmers with the same attributes. If the same farmers did not participate in contract farming, the expected value would then become

$E(Y_{is}|D_i = 1) = X\beta_{io} - \sigma_{ise},\lambda_o$ ……………………………………………(5)

For the non-
beneficiaries, the counterfactual's expected outcome for participation would be

$E(Y_{io}|D_i = 0) = X\beta_{is} - \sigma_{ioe},\lambda_s$ ……………………………………………...(6)

According to Lokshin and Sajaia (2004), from these equations, the unbiased estimate of the participation effects (treatment effect) could be obtained as presented in Table 1. This result was checked for robustness using inverse weighted augmented regression model.

Table 1. Average Treatment (ATE) and heterogeneity effects of ABOP on poultry sale output and net farm income

SUB-SAMPLE	DECISION STAGE		TREATMENT EFFECT
	PARTICIPATE	NOT-PARTICIPATE	
Farmers participating in contract farming (ABOP)	$E(Y_{io}|D_i = 1) =$ $X\beta_{io} - \sigma_{ioe},\lambda_o$	$E(Y_{is}|D_i = 1)=$ $X\beta_{is} - \sigma_{ise},\lambda_o$	ATT = $X(\beta_{io} - \beta_{is}) + \lambda_o(\sigma_{ioe} - \sigma_{ise})$
Farmers not participating in contract farming (ABOP)	$E(Y_{io}|D_i = 0)$ $X\beta_{i0} - \sigma_{ioe},\lambda_s$	$E(Y_{is}|D_i = 0)=$ $X\beta_{is} - \sigma_{ise},\lambda_s$	ATU = $X(\beta_{io} - \beta_{is}) + (\sigma_{ise} - \sigma_{ioe})\lambda_s$
Heterogeneity effect	$HH_{io} =$ $\beta_{io}(X_{io} - X_{is}) + \sigma_{ioe}(\lambda_o - \lambda_s)$	$HH_{is} =$ $\beta_{is}(X_{io} - X_{is}) + \sigma_{ise}(\lambda_o - \lambda_s)$	TH = $HH_{io} - HH_{is}$

Source: Authors' Compilation, 2022.

Results and Discussion

Socio-economic characteristics of poultry farmers

Table 2 describes the socio-economic characteristics of anchor-borrower programme beneficiaries and non-beneficiaries. The average age of the beneficiaries was 46.36$\pm$9.35 years, whereas, the non-beneficiaries had an average age of 44.73$\pm$10.44 years. The mean age obtained for the respondents was clearly above the youth age bracket of 15-35 years specified by the National Baseline Youth Survey (2012) which could mean youth have not been taking advantage of the contract farming. This result conformed with the findings by Adeyonu *et al.* (2016) who reported a mean age of 44 years for poultry farmers in Oyo State. Furthermore, the age difference between the beneficiaries and non-beneficiaries of anchor-borrower contract farming was not statistically significant (t=1.375, p>0.05). This result suggests that anchor-borrower participation may not necessarily give preference to farmer's age. The number of years it took an average farmer to acquire formal education was 13.45$\pm$3.31 years for the beneficiaries; 12.27$\pm$4.35 years for the non-beneficiaries. Years of formal education was

significantly higher for the beneficiaries than the non-beneficiaries as indicated by the independent t-test result (t=2.608, $p<0.05$). This finding is corroborated by the submission of Aromolaran *et al.* (2013) that on average, poultry farmers acquire higher education qualifications. The result also shows that more beneficiaries had tertiary education than the non-beneficiaries, which could be a key factor for participation in the programme. It is thus arguable that the highly educated farmers are more likely to participate in contract farming than the less educated folks owing to the advantage in contract negotiation, skill acquisition, and innovation response. This finding is corroborated by the submission by Wainaina *et al.* (2012) and Ouma *et al.* (2010) that the fear of being cheated by anchor groups may discourage the less educated farmers from making participation decisions. The t-test (t=2.538, $p<0.05$) and mean results respectively showed that household size was significantly larger for beneficiaries (5.77±2.99 persons) than the non-beneficiaries (5.68±3.04 persons). The mean poultry farming experience showed that beneficiaries (9.44±6.82 years) and non-beneficiaries (6.76±4.78 years) had a significantly different (t=3.718, $p<0.05$) farming experience in poultry farming. The implication is that an average participant farmer had considerably longer years of experience in raising birds than the non-participant farmer. This is in line with the findings by Adeyonu *et al.* (2016) that willingness to participate in the anchor-borrower contract farming increased with experience in the poultry enterprise. The average amount borrowed by the beneficiaries and non-beneficiaries was ₦660,156.25 and ₦285,636.36. The independent t-test (t=4.101, $p<0.01$) revealed that there was a significant difference between the amount of credit borrowed by beneficiaries and non-beneficiaries of anchor-borrower farming in the last 4 years. Average off-farm income per annum was ₦480,050.56±₦474,087.21 and ₦611,569.54±₦707,277.45 for the beneficiaries and non-beneficiaries respectively while the pooled data earned ₦523,331.52±537,702.21 per annum. The independent t-test result (t=2.231, $p<0.05$) showed that the off-farm income of the beneficiaries was statistically different from that of the non-beneficiaries of the anchor-borrower contract farming. It is inferred that the beneficiaries and non-beneficiaries were likely different in economic status. This higher average off-farm income for the non-beneficiaries may contribute to their non-participation in anchor-borrower contract farming among the non-beneficiaries.

The gender distribution reveals that there was no significant difference in terms of gender participation between the beneficiaries. This implies that both the male and female genders were likely to have equal participation rights in the Outgrowers' programme. Furthermore, the majority of the beneficiaries belonged to the Poultry Farmers' Association of Nigeria and had more access to credit. This is in line with the findings of Omodara *et al.* (2023) on the importance of credit access and association membership in outgrowers programme participation.

Table 2: Socioeconomic characteristics of poultry farmers

VARIABLES	BENEFICIARY	NON-BENEFICIARY	
	MEAN	MEAN	T-VALUE
Age (years)	46.36(9.350)	44.73(10.440)	1.375n.s.
Education qualification	13.45(3.309)	12.27(4.352)	2.608***
Household size	5.77(1.988)	5.68(3.037)	2.538**
Farming experience (Years)	9.44(6.824)	6.76(4.784)	3.718***
Amount of credit borrowed (₦)	660,156.25 (672,347.208)	285,636.36 (265,188.707)	4.101***
Amount of off-farm income	480,050.56 (474,087.21)	611,569.54 (707,277.446)	2.2310***
Gender	0.77	0.73	
Access to credit	0.64	0.50	
Poultry association membership	1.00	0.36	

**** p<.01, ** p<.05, * p<.1.* *n.s. means not significant*

Impact of contract farming on net farm income (NFI) of poultry farmers.

This section discusses the implications of the key findings, specifically focusing on how variables such as education, flock size, transaction cost, income, off-farm income, association membership, and distribution outlet influence the participation in contract farming. In addition, we found variables including flock size, sales price, transaction cost, and market location to affect the net farm income of beneficiaries. These relationships are further detailed in Table 3, which presents the full information maximum likelihood (FIML) estimates derived from the endogenous switching regression model (ESRM). The statistically significant correlation coefficients of the participation equation and NFI equation for beneficiaries (rho_1<0) indicate the presence of self-selection in the programme. This also suggests that anchor-borrower ABOP participation had a significant impact on the net farm income of the beneficiaries. The statistical significance of the likelihood ratio (LR=461.66233, Wald test of independence of equations=4.62, p<0.01) indicates that the three equations should not be estimated separately. The use of the endogenous switching income model, therefore, gives better estimates than the endogenous income model.

The second column in Table 3 represents the estimates of determinants of anchor-borrower contract farming participation among poultry farmers, while the third and fourth columns explain variables that determine the net farm income of participants and non-participants, respectively. Our findings in Table 3 show that farmers' age negatively influences participation in anchor-borrower contract farming. This indicates that younger farmers tend to adopt anchor-borrower contract farming practices, which is due to their heightened awareness of the contractual obligations and requirements necessary for active programme involvement. This is similar to the findings of Akumu *et al.* (2020), who posited that younger farmers are more willing to adopt contract farming than older farmers.

The coefficient of flock size is positively significant in participating in anchor-borrower contract farming, suggesting that only farmers with the capability to produce a larger number of birds are actively engaged in anchor-borrower contract farming. This stems from the model of contract farming practised in Nigeria, where only variable inputs such as feeds and vaccines are supplied to farmers, neglecting farmers without fixed inputs needed for poultry production.

Therefore, providing these facilities, such as land, buildings, and machinery to farmers through leasing arrangements in the short run will encourage more farmers to key into the programme.

Membership in a formal association group is necessary to participate in the various contract programmes in the study area. This corroborates the findings of Omodara *et al.* (2023), who stated the importance of belonging to associations in accessing various forms of public and privately sponsored contract farming programmes. They further explained the importance of association membership to provide members with additional benefits, including access to market information, new technology, and extension services.

The estimate for major distribution outlets is negative and statistically significant at 5%. This implies that farmers' problem of selling their market output brings farmers to participate in contract farming. According to Oya (2012), farmers are endeared to join contract farming due to the problems encountered in selling their produce through the various distribution channels.

The coefficient of off-farm income positively influences participation in anchor-borrower contract farming, suggesting that farmers who earn income from non-farming activities are more inclined to engage in contract farming. Having extra income from off-farm activities provides farmers with access to additional resources for purchasing inputs needed for participating in anchor-borrower contract farming. This aligns with previous studies conducted by Rumi et al. (2022) who noticed the prevalence of off-farm income among participants of contract farming.

The estimate of market risk negatively influences the adoption of anchor-borrower contract farming implying that the presence of market risk factors discourages farmers from participating in contract farming. Similarly, transaction costs negatively significantly influence participation. This implies that high transaction costs often refrain farmers from participating in contract farming.

The marginal effect of ABOP on the NFI of the beneficiary and non-beneficiary farmers is determined in Table 3. The result reveals that the net-farm income of the beneficiaries was influenced mainly by sales price (β=0.02, p<0.01), flock size (β=0.016, <0.01), and proximity to Lagos (β=0.005, p<0.1) while year of education (β=0.168, p<0.05); amount of off-farm income (β=0.005, p<0.1), transaction cost (β=0.006, p<0.05), and flock size (β=0.012, p<0.01) influenced net farm income of the non-beneficiaries of ABOP.

Table 3. Marginal effect of contract farming on net farm income of smallholder poultry farmers (Endogenous Switching Regression Model)

	SELECTION MODEL	OUTCOME MODEL	
		NET FARM INCOME	
VARIABLE	COEFF. (STD. ERROR)	BENEFICIARIES COEFF. (STD. ERROR)	NON-BENEFICIARIES COEFF. (STD. ERROR)
Age (year)	-0.0214* (0.012)	0.011(0.007)	-0.002 (0.015)
Education qualification	0.0260 (0.0683)	0.072 (0.064)	0.168**(0.081)
Major distribution outlet	-0.0670** (0.2770)	0.005 (0.020)	-0.028 (0.056)
Off Farm Income (₦)	0.0004* (0.00022)	-0.001 (0.001)	0.005*(0.003)
Transaction Cost (₦)	-0.0007***(0.0001)	0.007 (0.007)	-0.006**(0.003)
Credit Access	0.0332 (0.2367)	0.001 (0.137)	0.372 (0.299)
Sale Price (₦)	-0.0003 (0.0004)	0.002***(0.000)	-0.005 (0.004)
Vehicle Ownership	0.0970 (0.2471)	0.032 (0.162)	0.327 (0.404)
Bird Age (Week)	0.0078 (0.0249)	0.006 (0.010)	-0.025 (0.037)
Flock size (bird count)	0.0005***(0.0001)	0.005***(0.0006)	0.012***(0.005)
Proximity to Lagos		-0.374*(0.225)	-0.073 (0.493)
PAN membership	1.3087***(0.2530)		
Extension Access	0.2414 (0.2291)		
Productive Farm Asset (₦)	-0.1478 (0.953)		
Farm Location	0.0788 (0.0601)		
Market Risk Level	-0.0345**(0.1375)		
Distance To Market (kg)	0.0243 (0.0294)		
Distance To Road (kg)	-0.0312 (0.0504)		
/lns1	-0.505*** (1.156)		
/lns2	-0.301*** (0.178)		
/r1	1.428***(0.483)		
/r2	-0.085 (0.194)		
sigma_1	1832.505		
sigma_2	1492.094		
rho_1	0.112		
rho_2	0.406		
Wald test of indep. Eqns.:			
Log likelihood = -461.66233 ***			
chi2(1) =	4.62 **		

*** *p<.01,* ** *p<.05,* * *p<.1.*

According to Table 3, the coefficients of the age of the farmer, education, amount of off-farm income, transaction cost, access to credit, major distribution outlet, farm vehicle ownership, and bird age were not statistically significant showed that these variables played

negligible roles to independently improve the net farm income of the beneficiaries in the study area. On the other hand, the statistical significance of sales price and proximity to Lagos in the beneficiary's equation alone implies that these variables are essential determinants of the net farm income of the beneficiaries. Thus, given participation conditions, beneficiaries who sell at higher prices and far from Lagos can boost their net-farm income significantly.

Table 3 reveals that if the flock size of the poultry farmers expands by 1 percent, beneficiaries will increase net farm income by about 0.5 percent while non-beneficiaries will gain an additional 1.2 percent in net farm income. This means that there is a positive relationship between flock size and the net farm income of poultry farmers in the study area. It is however worthy of note that an unconditional increase in flock size will yield higher net farm income for the non-beneficiary farmers than the beneficiary farmers. This is probably because non-beneficiaries are free to sell birds at a higher market price and weight and buy inputs at a marginally higher price than the given fixed price of the beneficiary farmers. This means that the conditions of participation in anchor-borrower contract farming place an arbitrary ceiling on the extent of market participation of smallholder poultry farmers in southwestern Nigeria. This submission validates the findings by Omodele *et al*. (2014) and Odimegwe *et al*. (2015) in Ogun State. It also agrees with Ayinde *et al.* (2012) and Akidi (2016) that the farm income of poultry farmers is considerably determined by the volume of birds raised for sale.

Contrary to *a priori* expectation, the coefficient of farm proximity to Lagos State, a proxy for farm location from the nearest poultry market hub, had a negative correlation with the net farm income of the beneficiaries. A percentage change in location, for instance, from Osun to Ogun, will reduce the net-farm income of the beneficiary farmers correspondingly by 37 percent. This implies that the beneficiaries located farther from Lagos are likely to benefit more from market participation than those closer to Lagos. This suggests a better contract arrangement between the anchor group and outgrowers at locations farther from Lagos. Invariably, the anchor-borrower contract farm performs better in the region of Osun State than in Ogun State.

Similarly, and in agreement with *a priori* expectation, transaction costs had a negative correlation with the net farm income of the non-beneficiary farmers. A percentage increase in transaction cost for the non-beneficiaries will result in a corresponding 0.6 percent decline in their net farm income. According to Delgado *et al*. (1999), in an attempt to participate in the market, smallholder farmers incur costs resulting from trade negotiation and bargaining. Considering the nature of poultry farming in Nigeria, the bulkiness of these activities may be too costly for the non-beneficiary farmers, causing a delay in bird sales and non-fulfilment of many transactions. Reducing transaction costs is therefore key to improving the net farm income of non-beneficiary smallholder poultry farmers in the study area. This report agrees with findings by Okoye *et al.* (2016) that transaction cost limits the market participation of smallholder farmers in Nigeria.

The amount of off-farm income correlates positively with the net farm income of the non-beneficiaries. The result shows that non-beneficiary poultry farmers will earn an additional 0.5 percent net income as a result of a 1 percent increase in off-farm income activities. This suggests that increasing the farm expenditure share from off-farm income activities will have a positive effect on the farm income of poultry farmers. This submission goes in line with findings by Poole (2017) and Wainaina *et al.* (2012) among African smallholder farmers.

Table 3 also shows that the education level of poultry farmers correlates positively with the net farm income of the non-beneficiary farmers. The result shows that a 1 percent increase in the number of years used to acquire formal education will result in a corresponding 16.8 percent increase in net income among the non-beneficiaries. Recall that the average years of study for the non-beneficiaries were 12 years, equivalent to secondary education. This means that non-beneficiary farmers who have a tertiary education are likely to earn more from poultry farming.

This submission agrees with Poole (2017) and Wainaina *et al.* (2012), who opined that access to higher education enhances smallholder farmers' capacity to boost income from farming.

Heterogeneity treatment effect of contract farming on net farm income of beneficiary farmers

The effect of anchor-borrower contract farming on the net farm income (NFI) of the beneficiaries was examined in Table 4. The result showed that the conditional income treatment effect for the beneficiaries was ₦477,465.50(USD 1,164.55) while that of the non-beneficiaries was ₦485,446.32(USD 1,184.02) per cycle. If the beneficiaries had not participated, their income treatment effect would have been ₦319,832.75(USD 780.08) in a production cycle. On the contrary, if the non-beneficiaries had participated, they would have earned ₦623,333.33 (USD 1,520.33) in net farm income, resulting in ₦157,632.75 (USD 384.47) average treatment on the treated (ATT) and ₦137,887.01(USD 336.31) average treatment on the untreated (ATU), respectively. These average treatment effects were statistically significant at $p<0.05$. A positive transitional heterogeneity effect was, however, observed but insignificant and estimated as ₦19,745.74(USD 48.16). This is saying that there was barely any incremental income of the beneficiaries that could not be attributed to ABOP participation. This submission agrees with the findings by Ayinde *et al.* (2018) that ABOP had a positive effect on the income of the beneficiaries.

Table 4. Average treatment effect of contract farming on the beneficiaries' net farm income (Endogenous Switching Regression heterogeneity effect result)

MEAN OF OUTCOME VARIABLE	POULTRY FARMERS TYPE AND TREATMENT EFFECT	DECISION STAGE		AVERAGE TREATMENT EFFECT
		TO PARTICIPATE	NOT TO PARTICIPATE	
Net farm income (₦)	contract farming participation (ATT)	477,465.50	319,832.75	157,632.75***
	Contract farming non-participation (ATU)	623,333.33	485,446.32	137,887.01***
	Heterogeneity effect	(145,867.83)	(165,613.57)	19,745.74^{NS}

*Source: Author's compilation, 2021. *** means p<0.01; NS means not significant*

Mean prediction and post estimation test of robustness for net farm income (NFI)

The result from Table 5 predicted a positive and significant effect of ABOP on NFI. The estimated average treatment effect (ATE) of participation on the net farm income of poultry farmers was 14 percent and statistically significant at $p<0.01$. This estimate predicts that an average poultry farmer in the study area will be affected positively by about 14 percent of the net farm income if he had participated. Similarly, the conditional treatment effect (ATT) was about 20 percent and significant at $p<0.01$. This suggests that the average net-farm income per beneficiary poultry farmer in the study area will increase by about 20 percent than it would if he did not participate in the programme. This shows that anchor-borrower contract farming had a significant impact on the net farm income of the beneficiaries. It further means that if an average poultry farmer participates in contract farming, such a farmer will earn incremental income, however, the income gained by the farmers will be less than the income gained by the beneficiaries. This suggests that the beneficiaries are best positioned to earn the highest income from anchor-borrower contract farming.

Table 5. Mean net farm income prediction for the endogenous switching regression model and Augmented Inverse-probability-weighted regression adjustment (AIPWRA)

MODEL	ENDOGENOUS SWITCHING REGRESSION		AUGMENTED REGRESSION ADJUSTMENT	INVERSE-PROBABILITY-WEIGHTED
Treatment effects	ATT	ATE	ATT	POM
Coefficient	0.198***	0.144***	0.149***	0.104***
Std. Err.	0.206	0.013	0.012	0.015

*Note: data used 1000 replications to bootstrap the standard errors after changing bootstrap replications between 500 – 1,000 with no occurrence of significant change. Source: Field survey, 2021. *** means $p<0.01$*

In the AIPWRA model in Table 4.12, the ex-post estimates of the causal effects of participation in anchor-borrower contract farming on the net farm show that the ATT of anchor-borrower contract farming on beneficiaries' net-farm income was approximately 15 percent and significant ($p<0.1$). At the same time, the potential output mean (POM) of a random poultry farmer was about 10 percent of the net farm income. Thus, the potential impact of contract farming participation on the net farm income of poultry farmers was substantially positive, meaning contract farming had a positive impact on the net farm income of potential ABOP beneficiary poultry farmers which could translate to a spill-over effect on the welfare of poultry farmers in the study area. This submission agrees with the findings by Okeke *et al.* (2019) on Nigeria's rice production.

Conclusion and Policy Recommendations

This study modelled the impact of contract farming on the net farm income of farming households using a multi-stage sampling technique. It was therefore deduced that major distribution outlets, off-farm income, transaction cost, flock size, and poultry association membership significantly influence farmers' participation in anchor-borrower poultry contract farming. The findings from the second stage of ESRM indicate that several factors play a significant role in the income of both the non-participants and participants of the anchor-borrower poultry programme. Specifically, sales price and flock size are observed to have a positive impact on the net farm income of non-participants, while proximity to Lagos State (location) negatively impacts net farm income for non-participants. Additionally, among participants, variables such as education qualification and transaction costs negatively affect net farm income, while flock size and off-farm income positively influence their income. In line with the average treatment effect, participation in the anchor-borrower poultry contract farming positively influences the net farm income of the beneficiaries. Thus, Policymakers should consider reducing transaction costs for non-beneficiaries and provide greater access to fixed inputs such as land and infrastructure to encourage more participation in contract farming. Additionally, targeted outreach and education programmes for older farmers who are reluctant to participate should be a priority.

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