Vertical Integration and Cost Behavior in Poultry Industry in Ogun and Oyo States of Nigeria

Olasunkanmi M. Bamiro
Department of Agricultural Economics, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria.
E-mail: olasunkanmibamiro1999@yahoo.co.uk

Adebayo M. Shittu
Department of Agricultural Economics, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria. E-mail: amshittu@yahoo.com

ABSTRACT

In this article, the influence of vertical integration on cost behavior in poultry farming in southwestern Nigeria is examined. The study was based on primary data obtained in cross-section survey of 211 randomly selected poultry farms in the study area. An average farmer in the sample was 44 years old; 85% were males and 72% had tertiary education. An average poultry farm in the sample had 4,342 birds, about half of which were laying birds. A set of cost and revenue share equations estimated by Zellner's seemingly unrelated regression (SUR) method revealed that vertical integration (measured in proxy by value-added sales ratio) is feed and veterinary service using, labor saving, and output augmenting. However, the scale effect of vertical integration was found to be higher in layers production than what obtains in broilers and cock/cockerel productions. [EconLit citations: Q120, D240, R340]. © 2009 Wiley Periodicals, Inc.

1. INTRODUCTION

In recent times, poultry farmers in Nigeria have been suffering setbacks caused by rising cost of feeds and other inputs, significantly reducing net returns from these businesses (Aihonsu, 1999). For example, price of maize, a major ingredient in the production of poultry feeds, rose sharply from 3,318 per ton in 1991, to 17,560 per ton in 1996, and 25,824 in 2001. And following that, the price of eggs also rose from 23,555 per ton in 1991, to 241,451 in 1996, and 367,748 in 2001 (FAOSTAT data, 2007). A major outcome of such price increases, in a nation where at least two out of every three citizens (70.2% in 2002; UNDP, 2004) live in abject poverty, is a substantial decline in demand and a declining profitability (Aihonsu; Mbanasor, 2000). This has caused many poultry farms to exit and prospective investors are becoming increasingly reluctant to invest (Aihonsu, 1999).

This situation threatens the survival of poultry industry and calls for concerted efforts to save the industry from total collapse. Failure to do so could lead to a serious reduction in poultry production and protein intake of people resulting in malnutrition and ill health, which, again, will transform into lower productivity and output. There is, therefore, the problem of finding adequate means of increasing net returns to farmers in the poultry business. The net returns must be sufficient to retain farmers in the business and attract more participants.

Given the fact that the farmer has little or no control over the demand and prices of the products, because of the nature of the market which is more or less perfectly

competitive, a more plausible approach to increasing net return to farmers is to reduce the cost of production (Aihonsu, 1999). On the basis of the foregoing, poultry farmers need to seek means to reduce costs, risks, and thus increase the profitability of the poultry enterprise. According to Buzzel (1983) and Ouden, Dijkhuizen, Huirse, and Zuurbier (1996), the major objective of vertical integration is to eliminate or at least reduce the buying and selling costs incurred when separate companies own two stages of production. Kilmer (1986) also noted that vertical integration is a means of reducing risk and uncertainty.

Vertical integration can be defined as the combination of two or more stages of a production marketing chain under single ownership. Vertical integration may be backward or forward. Backward integration occurs when a firm decides to make rather than buy an input from an independent supplier. Forward integration occurs when a firm decides to use rather than sell one of its products to independent customers.

This article examines the implications of vertical integration on cost behavior in poultry industry in Nigeria. A set of revenue and cost share equations are used to analyze the impact of various inputs on cost of production, estimate the substitution ability of various inputs in poultry production, and assess the impact of vertical integration on the cost of production for Nigerian poultry farmers.

2. METHODOLOGY

This study was based on primary data obtained in a cross section survey of poultry farms in the Ogun and Oyo states in the southwestern part of Nigeria. The data were collected by personal administration of a set of questionnaire/interview schedule. This was designed to obtain information on socioeconomic characteristics of the farm owners, characteristics of the sampled farms, as well as cost data for the 2003/2004 production season.

Because no comprehensive list of poultry farms in the study area could be obtained *ab-initio*, the study resorted to the use of a purposive, snowball sampling process: Starting with the few farms originally identified based on information obtained from the two states' Ministry of Agriculture, identified feed milling centers and commercial feed sellers, other farms were identified through information obtained from those already sampled and interviewed as well as from sellers of poultry products identified in the major markets in the two states. The process yielded a total of 211 poultry farms covered by the study. We feel that the sample is a fair representation of the poultry industry in the study area.

The study data were analyzed by descriptive and quantitative (econometric) techniques. The quantitative analyses entailed specification and estimation of a transcendental logarithmic (translog) cost function of the poultry farms. The theoretical model underlying the analysis has its foundation in the neoclassical theory of cost and duality principles, which represent the implications of optimization in competitive markets (Dalton, Masters, & Foster, 1997). Detailed specifications of the theoretical framework are common in literature (e.g., Binswanger, 1974) and are widely used by related studies like Akridge and Hertel (1986), Kuroda (1995), and Dalton et al. (1997), among others.

3. MODEL SPECIFICATION

For the purpose of analyzing the influence of vertical integration on costs behavior as well as estimate factor demand/substitution elasticities for poultry businesses in the study area, the following translog cost function is specified following Binswanger (1974) and Kuroda (1995):

$$\ln C = \beta_0 + \sum_{h=1}^{3} \beta_h \ln Q_h + \sum_{i=1}^{5} \beta_i \ln P_i + \frac{1}{2} \sum_{i=1}^{5} \sum_{j=1}^{5} \beta_{ij} \ln P_i \ln P_j$$

$$+ \frac{1}{2} \sum_{h=1}^{3} \sum_{m=1}^{3} \beta_{hm} \ln Q_h \ln Q_m + \sum_{h=1}^{3} \sum_{i=1}^{5} \beta_{hi} \ln Q_h \ln P_i + \sum_{k=1}^{3} \sum_{i=1}^{5} \beta_{ki} Z_k \ln P_i$$

$$+ \sum_{k=1}^{3} \sum_{h=1}^{3} \beta_{kh} Z_k \ln Q_h + \epsilon \tag{1}$$

where

- C is the total cost of production (/farm).
- P_i or P_j is the unit cost (price) of the ith or jth ($i, j = 1, 2, \ldots, 5$) input, including P_1 average cost of birds stocked (/bird), P_2 wage rate (/worker per month), P_3 average cost of feed used (/kg), P_4 unit cost of veterinary services (/bird), and P_5 unit cost of other intermediate inputs, including water, energy, maintenances expenses, transportation, etc. (/bird).
- Q_h or Q_m is the quantity of the hth or mth ($h, m = 1, 2, 3$) output, including Q_1 for quantity of eggs (trays of average size eggs equivalent), Q_2 for quantity of broilers (number of average sized bird equivalent), and Q_3 for quantity of cock/cockerel (number of average size cockerel equivalent) produced. Please note that average-sized quantities were derived by dividing total value by average price of the referenced product in the entire sample. This standardization was considered necessary because of wide variation in sizes, weights, and other qualities (e.g., whole eggs or cracks) of products and absence of standard measures.
- Z_k is the kth farm characteristic associated with vertical integration, defined as follows:
- Z_1 is the dummy variable for type (age) of laying birds stock, 1 if "point of cage" and 0 if day old chicks. Please note that a good number of poultry farms in the study area buy their stock from other farms at point of cage (about 12–16 weeks), rather than raising the birds from day old (a form of vertical integration).
- Z_2 is the dummy variable for type of feed used: 1 if the farm used privately compounded and 0 if the farm used only packaged feeds purchased from commercial feed-millers. Traditionally, poultry farms supply commercial feed to their birds. As a cost-saving strategy, however, increasing numbers of farms in the study area now result to the use of privately compound feeds (Shittu et al., 2004; Bamiro, Shittu, & Kola-Olutokun, 2001), which is a form of vertical integration. Some of these farms had feed mills installed on their farms, while others patronize commercial feed milling centers where they purchase desired feedstuff and get them milled into feed of various types and nutrient composition at a fee (Bamiro et al.).
- Z_3 is the value added over sales ratio (VAR), computed following Buzzel (1983) as VAR = (sales−purchases) $*$ 100/sales. Please note that beside vertical integration

with respect to the type of birds stocked and feed (partly captured by Z_1 and Z_2), a wide range of cost saving strategies amounting to vertical integration was adopted by farms in the sample: Some farms had borehole/deep wells sunk on their farms to supply water (versus purchasing water from vendors); some recruited or trained some of their staff to handle routine veterinary operations (versus consulting external veterinary doctors); and many adopted direct product sales strategies (versus reliance on wholesalers/other middle men). Ceteris paribus, it is expected that the more and deeper the extent of these various vertical integration strategies adopted by a farm the higher the value added over sales ratio.

- βs are parameters associated with various explanatory variables in the model, which are distinguished by use of subscripts associated with related variables. These include h and m relating to the hth or mth output(s), i and j relating to the ith or jth input price(s), and k relating to the kth farm characteristic.
- ε is a stochastic error term.

Neoclassical theory suggests the matrix of second-order terms implicit in Equation (1) are symmetric ($\beta_{ij} = \beta_{ji}$ and $\beta_{hi} = \beta_{ih}$; note that i and j as well as h and m are similar). In addition, the cost function is homogenous of degree one in input prices such that $\sum \beta_i = 1$ and $\sum \beta_{ji} = \sum \beta_{hi} = \sum \beta_{hi} = 0$. Note that homogeneity of degree one in input prices does not impose homogeneity of degree one on the underlying production function, and almost no other constraints are imposed on elasticity of substitution or the factor demand derivable from the translog cost function in Equation (1) (Biswanger, 1974).

Logarithmic differentiation of the cost function and the use of Shepard's lemma yield the following cost share and revenue share equations:

$$S_i = \frac{\partial \ln C}{\partial \ln P_i} = \beta_i + \sum_{j=1}^{5} \beta_{ji} \ln P_j + \sum_{h=1}^{3} \beta_{hi} \ln Q_h + \sum_{k=1}^{3} \beta_{ki} Z_k; \quad i = 1, 2, 5 \quad (2)$$

$$R_h = \frac{\partial \ln C}{\partial \ln Q_h} = \beta_h + \sum_{j=1}^{5} \beta_{jh} \ln P_j + \sum_{m=1}^{3} \beta_{mh} \ln Q_h + \sum_{k=1}^{3} \beta_{kh} Z_k; \quad h = 1, 2, 3 \quad (3)$$

where S_i (i = stock, labor, feed, veterinary services, and other intermediate inputs) and R_h (h = eggs, broilers and cock/cockerels), respectively, are the share of production costs and farm income associated with the ith input and hth output. By imposing revenue share equations on the system, we are assuming that in addition to cost minimization behavior, the farms are maximizing profits.

Imposing homogeneity forces one of the input prices to be a *numèraire* price (Akridge & Hertel, 1986). Hence, unit costs (prices) of labor, feed, veterinary services, and other intermediate inputs (P_2–P_5) are expressed in terms of the stock price (P_1), and the share equation for stock (S_1) is dropped, yielding the following system of estimating equations.

$$S_i = \frac{\partial \ln C}{\partial \ln P_i} = \beta_i + \sum_{j=2}^{5} \beta_{ji} \ln(P_j/P_1) + \sum_{h=1}^{3} \beta_{hi} \ln Q_h + \sum_{k=1}^{3} \beta_{ki} Z_k; \quad i = 2, 3 \ldots 5$$

$$(4)$$

$$R_h = \frac{\partial \ln C}{\partial \ln Q_h} = \beta_h + \sum_{j=2}^{5} \beta_{jh} \ln(P_j/P_1) + \sum_{m=1}^{3} \beta_{mh} \ln Q_h + \sum_{k=1}^{3} \beta_{kh} Z_k; \ h = 1, 2, 3$$

(5)

Translog cost functions, such as in Equation (1), may be estimated directly or in its first derivatives (Biswanger, 1974). Joint estimation of the translog cost function with the cost/revenue share equations is also common, given that the indirect cost/revenue share approach does not provide estimate of the intercept term (β_0). An example of the latter approach is in Dalton et al. (1997). Despite this limitation, however, this study chose the indirect approach because the intercept term (β_0) is not required in our analysis of the influence of vertical integration on cost behavior as well as in estimating elasticities of factor demand and input substitutions.

Parameters of the system of Equations (4) and (5) were estimated jointly by the iterative seemingly unrelated regression (SUR) procedure in SHAZAM (Windows Professional edition), with the symmetry conditions implicit in the βs imposed during estimation. The constant output own-price and cross-price elasticities of factor demand were then estimated, following Biswanger (1974) and Johnston (1985) as follows:

$$\eta_{ij} = \frac{\beta_{ij} + S_i S_j}{S_i} \quad \text{for all } i,j; i \neq j$$

(6)

$$\eta_{ii} = \frac{\beta_{ii} + S_i^2 - S_i}{S_i} \quad \text{for all } i$$

(7)

where

- η_{ii} is the constant output own-price elasticity of demand for the ith factor.
- η_{ij} is the constant output cross-price elasticity of demand for the ith factor due to changes in price of the jth factor.
- β_{ij} is the parameter of the jth input price in the ith cost share equation.
- β_{ii} is the parameter of the ith input price in its own cost share equation.
- S_i and S_j are respectively the shares of the ith and jth input in the production cost.

Although Allen partial elasticities of substitution, as derived by Uzawa (1962), are more commonly presented in literature and was earlier used in this study, the measure seems to "have fallen out of favor given the lack of information they communicate.[1] Moreover, they do not indicate the curvature or ease of substitution between factors (Blackorby & Russel, 1989), which is what the study seeks to assess. Thus, elasticities of factor substitution reported finally in the study were the Morishima elasticities computed as follows:

$$\delta_{ij}^M = \frac{\beta_{ij} + S_i S_j}{S_i} - \frac{\beta_{jj} + S_j^2 - S_j}{S_j} \quad \text{for all } i \text{ and } j$$

(8)

where

- δ_{ij}^M is the Morishima elasticity of substitution of factor i for j.
- β_{ij}, β_{ii}, S_i and S_j are as earlier defined.

[1]Attention of this study was drawn to this fact by an anonymous reviewer.

Note that the Morishima measure is the difference between the constant output cross-price elasticity of demand Equation (6) and the own-price elasticity of demand Equation (7) of the denominating factor price. Thus, Blackorby and Russel (1989) noted that the effect of varying the jth input price can be clearly decomposed into two parts: the proportional effect on the ith input of varying the price of jth input (η_{ij}) and the proportional effect on the jth input for varying its own price (η_{ii}).

4. RESULTS AND DISCUSSION

A total of 211 poultry farms supplied the data used in this study. This consists of 115 farms drawn from Oyo state and 96 farms drawn from Ogun state. The following subsections present results of various analyses carried out on the study data.

4.1 Socioeconomic Characteristics of Sampled Farms

The socioeconomic characteristics of poultry farmers and farm characteristics considered in this study include the age, sex, educational status, occupation of the

TABLE 1.   Characteristics of Poultry Farm Owners

	Oyo State |(n = 115)		Ogun State (n = 96)		Entire sample (n = 211)	
Description	No	%	No	%	No	%
Ownership structure						
Sole proprietorship	93	80.9	74	77.1	167	79.1
Family based enterprise	20	17.4	14	14.6	34	16.1
Others	2	2.7	8	8.3	10	4.8
Gender of farm owners						
Male	94	81.7	86	89.6	180	85.3
Female	21	18.3	10	10.4	31	14.7
Age of farm owners (years)						
Below 40	42	36.5	36	37.5	78	37.0
40–<50	34	29.6	26	27.1	60	28.4
50–<60	18	15.7	24	25.0	42	19.9
60 or more	21	18.3	10	10.4	31	14.7
Highest education						
No formal education	8	7.0	–	–	8	3.8
Primary	4	3.5	–	–	4	1.9
Secondary	20	17.4	22	22.9	42	19.9
Diploma/NCE	25	21.7	8	8.3	33	15.6
Degree	58	50.4	66	68.8	124	58.8
Experience in poultry farming						
1–5	32	27.8	36	37.5	68	32.2
6–10	36	31.3	20	20.8	56	26.5
11–15	24	20.9	16	16.7	40	19.0
16–20	12	10.4	16	16.7	28	13.3
Above 20	11	9.6	8	8.3	19	9.0

TABLE 2. Farm Characteristics

State	Oyo state		Ogun state		Entire sample	
	Mean	Std. error	Mean	Std. error	Mean	Std. error
Bird population	4,686.78	699.78	3,929.65	791.27	4,342.30	523.86
Laying birds	2,344.35	355.35	1,937.67	258.59	2,159.32	226.54
Stock type (point of cage = 1)	0.47	0.05	0.71	0.05	0.58	0.03
Feed type (private feed = 1)	0.67	0.04	0.35	0.05	0.53	0.03
Has feed mill (yes = 1)	0.21	0.04	0.17	0.04	0.19	0.03
Number of farm employees	3.37	0.23	4.21	0.30	3.75	0.19
Gross revenue	9,671,816.45	1,489,667.50	6,434,000.07	808,395.37	8,198,686.72	896,355.23
Cost of birds stocked	812,331.44	94,908.70	910,105.72	142,574.56	856,816.42	82,826.60
Cost of feeds	4,610,436.54	618,041.66	3,244,595.33	408,401.78	3,989,011.15	386,713.73
Annual wages of employees	229,382.61	33,086.82	191,927.08	22,542.37	212,341.23	20,739.99
Cost of veterinary services	66,023.99	9,550.95	52,237.00	9,938.71	59,751.24	6,895.26
Other costs	59,554.78	8,165.47	77,109.65	8,705.40	67,541.83	5,974.03
Total cost	5,777,729.35	722,562.05	4,475,974.78	541,354.00	5,185,461.87	465,610.06
Gross margin	3,894,087.10	844,245.39	1,958,025.30	307,994.61	3,013,224.86	484,594.70
Value-added sales ratio	31.82	1.14	27.54	1.34	29.87	0.88
Net benefit cost ratio	51.68	2.75	42.90	2.83	47.69	1.99

poultry farmers, the flock size, as well as the extent of vertical integration. The results are presented in Tables 1 and 2. A sizeable percentage, 37% of the poultry farmers in both states are below 40 years of age. Poultry business in both states is gender biased. Occupational distribution of the farmers indicates that 38.3% and 46.8% of poultry farmers in Oyo State and Ogun state, respectively, have their main occupation as farming. The farming experience of the bulk of poultry farmers (about 68%) in Oyo state spans between 1–10 years, while about 58% of their counterparts in Ogun State have farming experience that spans between 1–10 years. A relatively high percentage of farmers in both states have tertiary education. The ownership structure in both states indicates that sole proprietorship dominates the poultry industry.

The poultry farm characteristics show that most poultry farms in Ogun State have flock size that is less than 1,000 birds while that of their counterparts in Oyo State ranges between 1,000 to 3,000 birds. The gross margin analysis and profitability indices value-added sales ratio and net benefit cost ratios indicate that poultry farms in Oyo State have higher economic performance than poultry farms in Ogun State.

Poultry farms are classified into three categories: nonintegrated, partially integrated, and fully integrated poultry farms. Nonintegrated poultry farms are commercial feed users. Partially integrated poultry farms are users of privately compounded feeds that are milled at commercial feed milling centers. Fully integrated farms use privately compounded feeds that are milled in their own feed mills. In Oyo State, 46% of the farms are partially integrated, and nonintegrated poultry farms dominate poultry industry in Ogun State. The overall analysis signifies that about 47%, 34%, and 15% of poultry farms in both states are nonintegrated, partially integrated, and fully integrated, respectively.

4.2 Cost and Revenue Shares

4.2.1. Statistical results and theoretical consistency. Given the number of estimated parameters, the statistical results in Table 1 are quite reasonable. Sixty-one percent (79.2%) of the estimated parameters have t-statistics greater than 1.96 (0.05 level). The system R^2 is 0.99: R^2s is 0.82 for the feed share equation, 0.79 for the veterinary services share equation, 0.60 for the labor share equation, 0.63 for the operating expenses share equation, 0.86 for the layer's output share equation, 0.82 for broiler's output share equation, and 0.76 for cock/cockerel share equation. The F-test for the regression rejected the hypothesis that all estimated parameters are zero at the 5%; level for each of the seven equations.

Several deductions were obtained from these results, including scale effect, effect of the extent of vertical integration (measured by value-added sales ratio) on cost share, as well as the effects of stocktype and feedtype on cost shares. Other deductions include estimates of elasticities of factor demand and elasticities of input substitution.

In general, differences or changes in production methods often referred to as *technological change* or simply *technical change* does not affect all factors equally. When it does, technical change is said to be *factor neutral*. This implies that at constant prices, factor shares remain the same irrespective of the production method (e.g., extent of vertical integration) used. In other words, technical change is said to be a specified factor neutral if the demand for the factor falls at the same rate as costs. Technical change is said to be a specified *factor using* (e.g., *labor using*) if the

demand for this factor falls less rapidly than costs, and the specified *factor saving* (e.g., *veterinary service using*) if the reverse holds. In factor-using and factor-saving scenarios, the cost share of the specified factor rises and falls respectively, as more of a production method is used.

4.2.2. Scale effect. The coefficients for the egg variables are significant at 0.05 level in the feed, veterinary services, and wages equation and 0.1 level in the other operating expenses equation. This means that at constant factor prices, the factor share would have changed with more egg production, which implies a non-neutral output effect in poultry industry. The coefficient for egg in the feed share equation is positive (0.0313). Hence, the scale effect is feed using, which implies that the quantity of feed vis-à-vis the share of the feed cost increases with the output of egg as one would expect. On the other hand, the coefficients of eggs in the veterinary services, labor, and other operating expenses equations are negative. This means that as more eggs are produced, the share of veterinary services cost, wages, and operating expenses decrease. This implies a decrease in veterinary service cost with an increase in the scale of production, which might be due to bulk purchase of the drugs and vitamins. Also, almost the same numbers of workers that were employed at the brooding stage of the birds are maintained even at the peak of the laying period; hence, the share of labor cost declines. The coefficients of the other operating expenses are not significant.

The coefficients of broiler in feed and other operating expenses equations are −0.0041 and −0.0062, respectively. Thus, the feed-saving and labor-saving scale effect. On the other hand, the positive coefficients of broilers in veterinary services and other operating expenses equations imply veterinary services-using and other operating expenses-using scale effects. This result, according to Bamiro et al. (2007), lends itself to theory and practice because farmers spend more money to buy growth stimulant, which will engender growth and development of flesh in broilers, so that they can reach market weight on time and thus attract high market value.

Feed, veterinary services, and labor in cock/cockerel production are not significant. The coefficient of other operating expenses is significant and scale effect using. The positive sign of the coefficient implies that the share of other operating costs, especially the cost of transporting the cock to the market, always increases with increase in production.

4.2.3. Effects of extent of integration on factor cost share. Value-added sales ratio was used as a measure of the extent of vertical integration. The coefficients of the value-added sales ratio are significant at 5% level in all the share equations with the exception of other operating expenses equation. The coefficients are positive in all the share equations with the exception of labor equation. The implication is that vertical integration (measured by value-added sales ratio) is feed using, veterinary services using, and labor saving. This means that the greater the extent of integration the higher the shares of feed and veterinary costs. This may be due to the large flock size in vertically integrated poultry farms, a situation in which overcrowding cannot be ruled out and thus render the birds susceptible to diseases and pest attacks. The negative sign of the coefficient of value-added sales ratio in the labor equation implies that share of labor cost or wages decreases with the extent of vertical

integration. This is plausible because as a farm combines two or more stages of production and marketing under a single ownership, the same set of workers that work in the poultry farms are also used in the feed mills and for other farm activities, hence the reduction in the labor cost. In the layers' output, broiler's output, and cock/cockerel output equations, the value-added sales ratio (the measure of extent of vertical integration) coefficients have the expected positive signs with a significant effect on output. This implies that the more vertically integrated a farm is the greater the level of output in the poultry industry.

4.2.4. Effects of stocktype and feedtype on share of factor cost and output in the poultry industry.
The effects of stocktype and feedtype in the share equations were evaluated using dummy variables. The coefficient of the dummy variable for stocktype is only significant at 0.05 level in the labor share equation. The negative sign of the coefficient is in consonance with a priori expectations, and it implies that stocking Point of Lay birds in the egg-based poultry enterprises (versus day-old chicks) is labor saving. This means that there is reduction in the share of labor cost for farms that stocked Point of Lay birds. Practically, this is expected because it requires fewer number of days and man days of labor to raise the Point of Lay to egg production stage than what is required when day-old chicks are raised. Moreover, farms that stocked point of lay begins to gather eggs as soon as the farms are stocked, unlike the farms that stocked day-old chicks, which cannot reap from egg sales until the eighteenth week rather the farms expend money on labor and drugs.

In the layers' revenue share equation, the coefficient of the dummy for stocktype is positive and significant at 5% level. This means that poultry farms that raised their birds from Point of Lay tend to have significantly higher layers of revenue share than those that raised their birds from day-old chicks. Note that revenue shares are defined as the fraction of the total cost that was realized as the revenue from layers enterprise expressed as a fraction of the total cost. With respect to broilers' revenue share equation, the coefficient of the dummy variable for stocktype is negative and significant at 5% level. This signifies increase in output of broilers when farms stock day-old chicks. The coefficient is not significant in cock/cockerel output equation.

The second variable for which dummy variable was used as proxy in the share equations is the feed type. The coefficients are significant at 5% level in share of feed and share of labor equations. It has no significant effect in share of veterinary services and share of other operating expenses equations. The coefficient of feed type in the feed equation is −0.0159; hence, the scale effect is feed type saving. This implies that utilization of privately produced feed reduces the share of feed cost, while the share of feed cost increases in farms that use commercial feeds. While poultry farms that used privately produced feed are able to reduce the share of feed cost, their share of labor cost increases. In other words, the scale effect is labor using because the coefficient of feed type in labor equation is positive. This may be due to the fact that farms employed more labor to handle the production of feed or increase in the salary of the workers because of additional jobs, with a consequential effect of high share of labor cost.

In the egg and cock/cockerel production enterprises, the coefficients of feed type are positive and significant at 5% level. This implies that privately produced feed leads to high production of eggs, byproducts, and cock/cockerel in sole egg poultry production enterprises and cock/cockerel production enterprises, respectively. On

the other hand, the coefficient of the feedtype in broiler's output equation is negative. This implies that output of broiler declines with privately produced feed. This could be attributed to high cost of producing broiler's mash, which includes broiler's starter and broiler's finisher. Therefore, it is more productive, profitable, and advisable for farmers in broiler production to use commercial feed than using privately produced feed.

4.2.5. Economies of scale.
Economies of scale or increasing return to scale exits when long-run average cost curve is decreasing. These economies can come from a number of sources, including the spreading of total fixed cost over a large amount of output. Full utilization of labor, machinery, and buildings is another factor. Diseconomies of scale, on the other hand, exist when the long-run average cost curve is increasing, and this combination discourages further increases in farm size. The results in Table 2 show that coefficients associated with layers' output, the broilers' output, and cock/cockerel's output are significant at 5% level. The results also reveal that the production cost of layers, broilers, and cock/cockerel increases with the level of output, hence the three forms of poultry enterprises in both Ogun and Oyo states experienced diseconomies of scale. This could be due to the underutilization of labor, machinery, and buildings.

4.3. Elasticities of Factor Demand and Substitution

The results of the elasticities of factor demand are reported in Table 2. All own price elasticities of factor demand have the correct sign. They are all negatives, implying that the demand for these resources decrease with increase in their respective prices. This result is consistent with the law of demand, which states that ceteris paribus, the quantity demanded of a commodity is inversely proportional to the price of the commodity.

   The low elasticities of demand for feed and other inputs, such as water, could be due to the fact that a farmer who stocked his farms has no choice; he is under obligation to buy or produce feed and simultaneously supply adequate quantity of water to the birds. These factors could therefore be regarded as necessities; changes (increase or decrease) in the price of these inputs have a negligible effect on the quantity demanded. The elasticities of demand for labor and veterinary services are relatively high, which suggests that their demands are less inelastic than that of feed and other inputs. This implies that the degree of response of quantity demanded of the latter to price will be higher than that of the former. The demand for stock is elastic with the price elasticity of demand of the input being greater than one. This is plausible because farmers will greatly reduce their demand for either day-old chicks or Point of Lay in reaction to any increase in price.

4.3.1. The cross-price elasticity of demand for factors.
Cross price elasticity of demand refers to the degree of responsiveness of quantity demanded of an input to the change in price of another factor. Positive cross price elasticity of demand means that the factors are substitutes, while negative cross price elasticity of demand implies that the inputs are complements. The results of cross-price elasticity of demand for the factors are presented in Table 2. The results reveal that feed-veterinary services pair; feed-labor and feed-stock pair are substitutes. The feed-other inputs

TABLE 3. Parameter Estimates for the Share Equations of a Translog Cost Function

| | | Explanatory variables | | | | | | | | | | |
| | | Prices/unit cost | | | | | Output | | | Other variables | | |
Share equation	Constant	Vet	Feed	Labor	Others	Stock	Eggs	Broilers	Cock	VAS	Stock type	Feed type
Vet. services $R^2 = 0.77$	0.0664	0.0104	−0.0057	−0.0010	−0.0009	0.0028	−0.0020	0.0009	−0.0002	0.0087	0.0005	−0.0010
	(12.46)	(17.44)	(−3.24)	(−1.22)	(−1.75)		(−10.40)	(5.66)	(−0.93)	(2.08)	(0.22)	(−0.96)
Feed $R^2 = 0.82$	0.3478	−0.0057	0.1611	−0.0336	−0.0159	0.1059	0.0313	−0.0041	−0.0081	0.0983	0.0107	−0.0159
	(10.27)	(−3.24)	(13.38)	(−4.93)	(−5.80)		(21.8)	(−3.61)	(−1.26)	(3.14)	(0.78)	(−2.00)
Wages $R^2 = 0.60$	0.1800	−0.0010	−0.0336	0.0335	0.0054	0.0043	−0.0185	−0.0062	0.0005	−0.2098	−0.0267	0.0268
	(6.01)	(−1.22)	(−4.93)	(5.42)	(2.93)		(−13.91)	(−6.14)	(0.41)	(−7.30)	(−3.01)	(3.65)
Other operating expenses $R^2 = 0.63$	0.0588	−0.0009	−0.0159	0.0054	0.0186	0.0072	−0.0008	0.0006	0.0011	0.0085	0.0029	−0.0032
	(6.01)	(−1.75)	(−5.80)	(2.93)	(15.26)		(−1.75)	(1.61)	(2.58)	(0.83)	(0.81)	(−1.24)
Stock	0.3470	0.0028	0.1059	0.0043	0.0072	−0.1202	−0.01	0.0088	0.0004	0.0943	0.0126	−0.00701
Layers' output $R^2 = 0.86$	0.1787	−0.0020	0.0313	−0.0185	−0.0008	−0.0100	0.0683	−0.0557	−0.0049	1.8161	0.0594	0.0622
	(3.99)	(−10.40)	(21.80)	(−13.91)	(−1.75)		(21.23)	(26.10)	(−3.83)	(19.78)	(2.41)	(2.67)
Broilers' output $R^2 = 0.82$	0.6357	0.0009	−0.0041	−0.0062	0.0006	0.0088	−0.0557	0.0503	−0.0044	0.2648	−0.0802	−0.0683
	(16.03)	(5.66)	(−3.61)	(−6.14)	(1.61)		(−26.10)	(21.42)	(−4.59)	(2.98)	(−3.36)	(−3.02)
Co-ck/cockerel Output $R^2 = 0.76$	0.0780	−0.0002	−0.0018	0.0005	0.0011	0.0004	−0.0049	−0.0044	0.0282	0.0598	0.0050	0.0143
	(4.71)	(−0.93)	(−1.25)	(0.41)	(2.58)		(−3.83)	(−4.59)	(20.52)	(1.98)	(0.60)	(1.83)

Note: t statistics in parenthesis below each parameter estimate.

pairs and all other factors and other inputs pairs, on the other hand, are comple-
ments. The same relationship exists between the remaining factors. These results are
theoretically correct and practically plausible. The result implies that as the price of
feed increases, less feed is purchased and more of veterinary services, labor, and
other inputs are demanded and utilized. With respect to feed-veterinary services pair,
a reduction in quantity of feed fed to the birds due to increase in price will compel
the farmers to substitute the feed with drugs such as booster and vitamins that will
boost growth in broilers and cockerel and egg production in layers. The cross-price
elasticity of demand of all the inputs are inelastic, meaning that change in price of
one input will lead to a slight change in demand for its substitutes. The com-
plementarity of other inputs, feed, and all other factors considered in this study
implies that an increase in the price of feed, for instance, will reduce demand for feed
and a consequential decrease in demand for other inputs. This could be due to the
fact that high demand for feed, labor, and stock necessitates high demand for water
and transportation.

4.3.2 Elasticity of substitution. The relationships between the inputs discussed
above are easier to evaluate by looking at the elasticities of substitution in Table 3
because the latter reflects the relative importance (change) of a factor while the
former do not. Elasticity of inputs substitution measure the ease of substitution with
which the inputs can be substituted for the other. Ease of substitution increases as
elasticity of substitution (σ) increases. The results in Table 3 show that the feed–
veterinary pair have a high degree of substitutability. This is expected because suf-
ficient quantity and good quality feed will reduce the susceptibility of the flock to
diseases and pests attack. A large substitution possibility exists between labor and
other inputs. This implies that if there is a relative fall in labor cost or a relative
increase in the costs of other inputs, we can expect to see a greater intensity use of
labor. But the degrees of substitutability between feed and other inputs and
veterinary services and other inputs are relatively low. In the same vein, veterinary
services and labor pair have a relatively low elasticity of substitution. This implies a
low degree of substitutability. This is in consonance with a priori expectations
because more workers might not completely eliminate diseases and pest attack;
however, more dutiful and efficient workers can, to some extent, reduce diseases and
pest attacks in poultry farms if a clean environment that is conducive for the healthy
growth of birds is provided and maintained. The elasticities of substitution for
stock and any other inputs are greater than one. This implies a high degree of
substitutability between stock and all inputs.

5. CONCLUSION

Vertical integration, most especially by privately producing own feed rather than
purchasing packaged feed from commercial feed millers, has been an emerging
strategy by which increasing numbers of poultry farms in Nigeria contend with
sharply rising costs of raising poultry birds. In general, vertical integration is
commonly aimed at improving efficiency and effectiveness of business operations,
reducing risks and uncertainty, and lowering transaction costs (Buzzel, 1983; Ouden
et al., 1996). This article presents empirical evidence, relating to the influence of

vertical integration on cost behavior in poultry farming in southwestern Nigeria. The study was based on primary data obtained from a cross section of 211 poultry farms drawn by snowball sampling from Ogun and Oyo states in the southwestern part of Nigeria. As much as 79.1% of these farms were run by sole proprietors, whose average age was 44 years of which 85% were males and 72% had been educated up to the tertiary levels. An average poultry farm in the sample had a total of 4,342 birds of which about half were laying birds, while the rest were replacement stocks, cockerels, or broilers.

Evidence from a set of cost and revenue share equations revealed that vertical integration (measured in proxy by value-added sales ratio) is feeds and veterinary services using, labor saving, and output augmenting. In other words, factor shares do not remain the same as poultry farms become vertically integrated by privately producing its feeds, raising birds from day-old versus point of cage, or trying to produce some of its other inputs: Shares of feeds and veterinary services in the production costs tend to be raised, while labor shares tend to fall as poultry farms become more vertically integrated. The coefficients of value-added sales ratio in output equations were 1.82 for layers, 0.27 for broilers, and 0.060 for cock/cockerel. This implies that vertical integration has a higher positive effect on output in layer production compared with broilers and cock/cockerel productions.

ACKNOWLEDGMENTS

REFERENCES

Aihonsu, J.O.Y. (1999). Optimal laying period for profitable and sustainable egg production. Journal of Agriculture, 20(1 & 2), 67–80.

Akridge, J.T., & Hertel, T.W. (1986). Multiproduct cost relationships for retail fertilizer plants. American Journal of Agricultural Economics, 68, 928–938.

Bamiro, O.M., Phillip, D.O.A., & Momoh, S. (2006). Vertical integration and technical efficiency in poultry (egg) production in Ogun and Oyo states, Nigeria. International Journal of Poultry Science, 5(12), 1164–1171.

Bamiro, O.M., Shittu, A.M., & Kola-Olutokun A.S. (2001). Private feed production as a cost reduction strategy: Effects on profitability of poultry business in Ogun State, Nigeria. The Ogun Journal of Agricultural Sciences, 1(1), 37–51.

Binswanger, H.P. (1974). A cost cunction approach to the measurement of factor demand elasticities and elasticities of substitution. American Journal of Agricultural Economics, 55, 377–386.

Blackorby, C., & Russel R.R. (1989). Will the real elasticity of substitution please stand up: A comparison of the Allen Uzawa and Morishima elasticities. American Economic Review, 79(4), 882–888.

Buzzel, R.D. (1983). Is vertical integration profitable? Harvard Business Review, 61(1-6), 92–102.

Chambers, R.G. (1988). Applied production analysis. New York: Cambridge University Press.

Dalton, T.J., Masters, W.A., & Foster, K.A. (1997). Production costs and input substitution in Zimbabwe's smallholder agriculture. Agricultural Economics, 17, 201–209.

Food and Agriculture Organisation of the United Nations (FAOSTAT). (2007). FAOSTAT dat. Rome. http://www.faostat.fao.org/

Kilmer R.L. (1986). Vertical integration in agricultural and food marketing. American Journal of Agricultural Economics, 68, 1155

Kuroda, Y. (1995). Labor productivity measurement in Japanese agriculture, 1956–90. Agricultural Economics, 12, 55–68.

Mbanasor, J.A. (2000). The future of livestock industry in Nigeria. Proceedings of the 25th annual conference of the Nigerian Society of Animal Production (NSAP). March 19–23, 2000.

Ouden, M. den, Dijkhuizen, A.A., Huirse, R.B.M., & Zuurbier, P. J. P. (1996). Vertical cooperation in agricultural production. Marketing chains, with special reference to product differentiation in pork. Agribusiness, 12(3), 277–290.

Shittu, A.M., Olayode, G.O., Bamiro, O.M., & Fehintola, A.M. (2004). Effect of using non-conventional feedstuff on the productivity and cost of egg farms in Ibadan, Nigeria. Nigerian Journal of Animal Production, 31(1), 65–78.

United Nations Development Programme (UNDP). (2007). Fighting climate change: Human solidarity in a divided world. Human Development Report 2007/2008. UNDP, New York, USA.

Olasunkanmi Moses Bamiro *is a lecturer at the Department of Agricultural Economics, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria. Degrees earned: BAgric in agricultural economics from Obafemi Awolowo University, Ile-Ife (1989); MSc in agricultural economics from the University of Ibadan, Nigeria (1991); and PhD in production economics form the University of Agriculture, Abeokuta (2008). His research interests include applied microeconomic analysis, consumer behavior, and rural development.*

Adebayo Musediku Shittu *is lecturer at the Department of Agricultural Economics, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria. Degrees earned: BAgric in agricultural economics from Ogun State University, (Now Olabisi Onabanjo University), Ago-Iwoye (1992); MSc in agricultural economics from the University of Ibadan, Nigeria (1995); and currently working on a PhD in agricultural economics program at University of Agriculture, Abeokuta, Nigeria. His research interests include applied microeconomic analysis, labor economics, and production efficiency in African agriculture.*