

**ECONOMICS OF QUAIL AND CHICKEN EGG PRODUCTION AND
MARKETING IN KANO METROPOLIS, NIGERIA**

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(SPS/11/PAE/00002)**

JUNE, 2019

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MARKETING IN KANO METROPOLIS, NIGERIA**

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**A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL
ECONOMICS AND EXTENSION, BAYERO UNIVERSITY, KANO, IN
PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF
THE DEGREE OF DOCTOR OF PHILOSOPHY (PhD) IN AGRICULTURAL
ECONOMICS**

JUNE, 2019

DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of Professor Z. Abdu and Professor A. B. Mohammed and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.



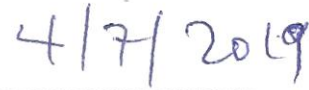
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CERTIFICATION

This is to certify that the research work for this thesis and the subsequent write-up by MUSA IBRAHIM (SPS/11/PAE/00002) were carried out under our supervision.



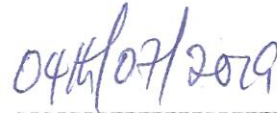
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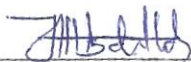
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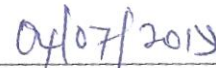
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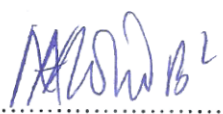
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APPROVAL PAGE


This thesis has been examined and approved for the award of Doctor of Philosophy (Ph.D) in Agricultural Economics in the Department of Agricultural Economics and Extension, Bayero University, Kano, Nigeria.


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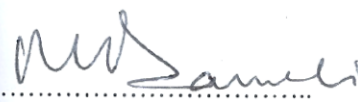
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DEDICATION

This thesis is dedicated to my Late Parents;
Alhaji Ibrahim Jibrin and Malama Zainab Musa.

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ABSTRACT

Broad objective of the research was to examine the economics of quail and chicken egg production and marketing in Kano metropolis, Nigeria. Quail egg producers were purposively selected using referral sampling while Chicken egg producers were randomly selected from sampling frame obtained from the list of poultry producers association. Producers were segregated into small and medium scales while the marketers into retailers and wholesalers. Descriptive statistics, Stochastic Frontier Analysis (Frontier 4.1), Costs and return analysis, Gini coefficients and marketing margin analyses were used to achieve the objective. Quail productions and marketing were dominated by males. 65.7% and 63% of the quail and chicken medium-scale producers have tertiary education. Age of retail marketers was 38 on the average, 70% of them having tertiary education. 74.4% of small-scale quail egg producers fall within 0.90 technical efficiency levels while chicken egg producers were 42%. Both the small-scale producers fall within 0.10 - 0.43 allocative efficiency level with most efficient producer having 0.11 and 0.12 locative efficiency in quail and chicken egg production respectively. In medium-scale production the most economically efficient quail egg producer has 0.098 and chicken egg producer has 0.100 indicating that chicken egg producers were more efficient economically. Mean value of weekly sales in quail egg marketing was ₦41, 889 with Gini coefficient of 0.71. Mean value of weekly sales in chicken egg marketing was ₦106,482 and Gini coefficient of 0.77 meaning there was 77% inequality in the size and distribution of marketers. Market conduct indicates an existence of exploitative relationship between producers and the marketers of both products. The Net Farm Income (NFI) was ₦244,483 and ₦1,252,043 for small and medium scales quail egg production respectively; for chicken egg production NFI was ₦239,009 and ₦550,136 in small and medium scales respectively. The total revenue per seller in quail egg marketing per week was ₦12,200 and ₦63,141 in retail and wholesale marketing respectively; chicken egg retailer makes ₦67,733 while wholesaler makes ₦124,469 weekly. Non-natural brooding was ranked first in quail egg production problems while high cost of feed was first in chicken egg production. Inadequate advertisement was ranked first among the problems associated quail egg marketing while inadequate capital was ranked first in chicken egg marketing. In conclusion the study revealed that quail egg enterprise is more profitable than chicken egg with a return to naira invested of ₦83 and ₦11 respectively. Recommendations includes: the need to look for an alternative sources of feed due high cost and acquisition of brooding techniques.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Chicken production has been in practice over the years beginning with the local and later improved breed. Initially chicken were kept to serve as an income reservoir by many families to cater for their emergency needs. Poultry keeping has been a useful means of livelihood to many farming families in Nigeria and World over where it provides pecuniary and nutritional benefits. The new Agricultural policy's primary focus includes closing the demand-supply gap in livestock production. Gap between demand and supply of chickens is filled with illegal imports that enter market at lower price point than domestic producers (FMARD, 2016). This lag in poultry production has remained major source of worry to the government and other relevant stakeholders in the agricultural sector.

The current level of food insecurity calls for well-defined approaches in meeting the desired objectives. One of the generally adopted approaches is increased production and productivity of the poultry sub-sector (Ewubare & Ozar, 2018). The Food and Agriculture Organization is of the view that poultry production forms an important component of the livestock sub-sector in Nigeria and by far the largest livestock group (Emokaro, Akininola and Emokpe, 2016). According to Ukwuaba and Inoni (2011), the poultry industry in Nigeria has undergone significant transformation since fifties from backyard subsistence and primitive house hold oriented husbandry of chickens to the cash oriented modern and large-scale poultry. It is therefore clear that much still need to be done to reaccelerate the transformation of the sub-sector in the interest of present and intending commercial poultry farmers in the country.

With Nigeria's teeming population, the country has not been able to meet the recommendation of Food and Agriculture Organization's (FAO) protein intake requirements of 65gm per person/day (FAO, 2013). According to Aromolaran, Ademiluyi and Itebu (2013) the development of the poultry industry has been described as the fastest means for bridging the protein deficiency gap prevailing in most developing countries. Diversification into production of livestock with short generation interval will be a viable tool in ameliorating shortage of protein among the populace in developing countries like Nigeria. This led to search for alternative cheaper source of poultry production and subsequent introduction of quail birds in Nigeria.

Ngele, Egbo and Jonathan (2011) observed that the human population for sub-Saharan Africa has been projected at one billion by 2020. Nigeria with annual growth rate of 3.3% would contribute a major percentage of the anticipated population growth, with an estimated population of 200,677,027 in 2019 (NPC, 2006). This has serious economic implication in terms of farmers' income and food production to feed the populace.

The importance of animal protein in both human and animal nutrition cannot be overemphasized. Over the years, there has been a significant gap between the production and supply of animal protein to feed the ever-growing population (FAO, 2013). To halt this negative trend, efforts are being directed towards boosting the livestock industry with micro-livestock having prolific tendency, short gestation period, short generation interval and rapid growth (Ngele *et al.*, 2011). According to Sathiyaa, Pazhanisamy and Banumathy (2017), the continued rise in human population in the developing countries necessitates the need to establish additional sources of animal protein. To meet up the growing demand for poultry products without

importing them, the development of poultry industry is very important. Quail does not only supply animal protein in forms of meat and eggs but also provide source of income (Sathiya *et al.*, 2017).

It is believed that promoting quail production would greatly help in securing the future of global food supply. It would also supplement domestic chicken production thereby increasing the availability of animal protein.

Quail is the smallest avian species farmed for meat and egg production and it has also assumed world-wide importance. Distinct characteristics include rapid growth which enables quail to be marketed for consumption at 5 to 6 weeks of age, early sexual maturity which results in short generation interval, high rate of lay and much lower feed and space requirements than other poultry birds (FAO, 2013). Sathiya *et al.* (2017) reported that quail's short reproduction cycle and earlier marketing age make it a fast income generator and a suitable alternative farm animal that will provide gainful farm income.

In Nigeria, Japanese quail (*Coturnix coturnix japonica*) was first introduced on 18th December 1992 by the NVRI with the support of the defunct Directorate of Food, Road and Rural Infrastructure (DFRRI) and Bobwhite quail in 2005. Four hundred and fifty fertile eggs of Japanese quail were said to be imported from the republic of Benin into Jos, Plateau State, Nigeria (NVRI, 2008). The purpose was to diversify the poultry sub-sector and help supplement domestic chicken production through massive quail farming by Nigerian farmers. Since then, quail farming has been growing in popularity in Nigeria (Ngele *et al.*, 2011).

Quail bird is known as “*Fakara*” in Hausa language, it exists in the wild which is mostly familiar or known among traditional hunters or remote rural dwellers in Kano and neighbouring States. Domesticated quails were first introduced into Kano in 2008

and now the bird is domesticated and attained commercial production level in the State.

There is a deficit of 60 million tonnes of required chicken in Nigeria the gap which needs to be closed (FMARD, 2016). Improved production of quail and access to markets will not only close the gap between the demand and supply of bird but will also increase income and upgrade the standard of living of the farmers as well as employment generation in the study area; hence the need to conduct the study on economics of quail and chicken egg production and marketing in the area.

1.2 STATEMENT OF THE PROBLEM

It is evident that poultry industry is performing far below its potentials and expectations in Nigeria. The industry falls short of its aim of self-sufficiency in animal protein supply in Nigeria. Over the years, there has been a significant gap between the production and supply of animal protein to feed the ever-growing population in Nigeria. According to Federal Ministry of Agriculture and Rural Development (FMARD) (2016) there is an existing deficit of 60 million tonnes of chicken supply in Nigeria, a gap which needs to be filled in order to ensure food adequate food security in the country. Many commercial poultry farmers were forced out of business due to high cost of inputs especially cost of feed, prevalent disease outbreaks, poor products output and importation of the products resulting in decline in products supply, farm income, employment level and standard of living (Ngele *et al.*, 2011).

FAO (2013), reported an obvious problem of inadequate amount of animal protein in diets of large proportion of the Nigerian populace. Animal protein is very important for general development of the human being. Its deficit has serious adverse effects on the economic development of the country. The poultry industry has the potentials of

reversing the inadequate protein intake in Nigeria because it has the advantage of fast growth rate and efficiency in feed conversion if right steps are taken to transform the sub-sector. Neglects with regard to promotion of quail farming caused reduction in farmers' income and employment generation.

According to Arinze (2013), quail farming is not very popular in Nigeria as in other African countries like Kenya, Benin, Egypt, South Africa and host of others; the few farmers that have adopted it in Nigeria are now getting additional income, they are also enjoying the nutritional and health benefits derived from consuming it; it is no doubt a past growing farming business that may gradually take over chicken- poultry business in the country. Production of quails in Kano rose significantly in the first few years after its introduction in 2008 but unfortunately began declining in 2014 due to insecurity in the country.

According to Adeyemo and Onikoyi (2012), some of the problems of poultry production include among others, poor marketing information system which makes marketing planning to be difficult. In many parts of the world agriculture continues to play a central role in economic development and a key contributor to poverty reduction, but unstable markets for the products made it difficult for the sector and sub sectors to economically and optimally perform (UNIDO, 2009). Ojekunle (2013) and Bakoji, Haruna, Jubril, Sani and Danwulle (2013), also believed that there is poor market for the quail products mostly at initial take-off of the business. Commercial success requires thorough market research and the ability to maintain supplies of top-quality products. Marketing problems faced by egg marketers; include price fluctuation, transportation, poor sales, lack of capital and record keeping (Mohammed *et al.*, 2013). Over the years contributions of the livestock sub-sector to Gross

Domestic Products (GDP) have decreased from 5.61% in 1960 to about 2.64% in 2010 (CBN, 2010).

In Kano Metropolis, the problem of quail enterprises includes; the majority commercial chicken egg farmers appeared not to accept quail as an additional enterprise, quails were first presented to consumers as medicinal alternative instead of proteins source, at initial take up of the enterprise producers were less organized and the market was not well coordinated. In order to determine the viability of quail and chicken eggs enterprise in the study area it is imperative to examine the economics of Quail and Chicken egg production and marketing via answers to the following questions:

1. What are the socio-economic characteristics of the quail and chicken egg producers and marketers?
2. What are the technical, allocative (cost) and economic efficiencies in quail and chicken eggs production?
3. What are the costs and return in quail and chicken eggs production and marketing?
4. What is the structure and conduct in quail and chicken egg marketing?
5. What are the major problems associated with quail and chicken egg production and marketing?

1.3 OBJECTIVES OF THE STUDY

The broad objective of the study is to examine the economics of quail and chicken egg production and marketing in Kano metropolis, Nigeria. The specific objectives are to:

1. describe the socio-economic characteristics of quail and chicken egg producers and marketers,

2. determine the technical, allocative (cost) and economic efficiency in quail and chicken egg production,
3. estimates the costs and return in quail and chicken egg production and marketing,
4. describe the structure and conduct of quail and chicken egg marketing,
5. describe the major problems associated with quail and chicken egg production and marketing.

1.4 JUSTIFICATION OF THE STUDY

Ensuring adequate supply of animal protein to the ever-growing population of Nigeria means the output of animal protein sources has to be increased especially via early maturing livestock such as quail bird. To achieve the policy, aim of bridging the gap of 60 million tonnes of chicken supply in the country, results of this study is important.

The high rate of returns and low cost of investment in rearing quails are some of the reasons some farmers are resorting to quail farming, as a result, there is need to conduct a research on the economics of production and marketing of quail and chicken eggs to exploit their benefits. The result of the study would bring to light the variables that can positively increase quail and chicken eggs production to increase the local demand and provide the minimum protein intake required by FAO. The two enterprises' contribution to producers and marketers' income made it a viable and an additional or alternative source of income as well as supportive economic activity.

This research result would benefit the quail and chicken egg producers and marketers in shedding light on the nature of returns to investment in quail and chicken egg farming and accessibility to markets. Farmers will have more alternative options when deciding in which enterprise to invest in. Quail farming has gained global acceptance

and reached the global markets and become alternative to chicken products (Hameed & Ahmed, 2012).

Presently, quail enterprise is not fully accepted by the chicken egg farmers in the study area; therefore, there is need for the research to promote in comparison between quail and chicken egg farming and hoped that this result will not only be useful in reducing the animal proteins deficiency but will also diversify additional income sources and improved productivity and accessibility to markets by the two commodity producers for improvement in their living standards.

The research would equally benefit government policy makers in the process of policy formulation especially at this era of economic diversification efforts in which poultry sub-sector is one of the areas of concern as the development of quail enterprises will create jobs and increase wealth; equally to the researchers that might go into similar research in the area of study. And finally, it is hoped that the findings of the research would contribute to the existing body of knowledge.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 QUAIL BIRD

The quail (*Coturnix japonica*) is a small bird that inhabits woodland and forest areas around the world. There are thought to be more than 15 different species of quail, with each species of quail being found in different parts of the world and all have slightly different appearances depending on how they have adapted to their environment. Quails range in size depending on the species from the Japanese quail (*Coturnix japonica*) which is around 10cm tall to the larger mountain quail that can grow up to 25 cm tall (a-z animal, 2013).

The Japanese quail belongs to the order *Galiformes*, family *Phasidae*, genus *Coturnix* and species *japonica* (Vali, 2008). Several aspects account for its utility. First, it has attained economic importance as an agricultural species producing eggs and meat that are enjoyed for their unique flavor. Egg production is important in Japan and Southeast Asia, while meat is the main product in Europe and in Nigeria too quail egg is the more important product. Second, the low maintenance cost associated with its small body size (80-300 g) coupled with its short generation interval, (3-4 generation per year), resistance to diseases and high egg production. Third, Japanese quail also is the smallest avian species farmed for meat and egg production (Vali, 2008).

According to Roysfarm (2015), the Japanese scientists first tamed the wild quails and revealed the ways to raise them as domestic birds that is for game and food. Now, throughout the world quail is commercially raised for the purpose of meat and egg production. Commercial quail production is very profitable like other poultry ventures. Meat and eggs of quail are very tasty and nutritious. Quail eggs are very nutritious than other poultry eggs. Because quail eggs contain comparatively more

protein, phosphorus, iron, vitamin A, B1 and B2. Quail farming can play a vital role to meet up the demand of food and nutrition. Quail production requires small capital and labour. Quails can be raised along with other poultry birds for meat or eggs production.

Japanese quails are produced mainly for their eggs and meat. Starters from day-old to four weeks of age are reared in brooder cages provided with strong lighting to give heat. They are fed 3 times daily with quail starter mesh. Growers and layers are from four weeks to about one year old. They are housed in layer cages which are 5 or 6-tiered. They are fed with quail layer or breeder feed twice daily. Lighting is left on during the night to stimulate the birds to lay eggs (Shim, 2015).

An adult quail weights between 150 to 200 grams, female quails start laying eggs from their 6 to 7 weeks of age (Roysfarm, 2015). Each egg weights between 7 to 15 grams. They lay more than 300 eggs per year. Presences of light increase the egg productive efficiency of quails. They usually lay eggs at afternoon. It takes about 17 days to hatch their eggs. A newly born quail chick weights around 6 to 7 grams. Quail never incubate their eggs. For successful breeding purpose keep one male quail with every five female quails. Quail chicks become very sensitive and take about two weeks to be strong enough. Eggs of 9 to 11 grams weight with smooth and hard eggshell are perfect for hatching and producing chicks (Roysfarm, 2015).

According to Shim (2015), the adult male *coturnix* weighs about 100 to 140 grams (3 1/2 to 5 ounces). The male birds can be identified readily by the rusty brown colour feathers on the upper throat and lower breast region. Males also have a cloacal gland, a bulbous structure located at the upper edge of the vent which secretes a white, foamy material. This unique gland can be used to assess the reproductive fitness of the males. The adult female *coturnix* is slightly heavier than the male, weighing from

120 to 160 grams (4 to 5 1/2 ounces) (Shim, 2015). The body coloration of the female bird is similar to the male except that the feathers on the throat and upper breast are long, pointed, and much lighter cinnamon. Also, the light tan breast feathers are characteristically black-stippled.

Quail (*Coturnix*) eggs are characterized by a variety of colour patterns. They range from snow white to completely brown. More commonly they are tan and dark brown speckled or mottled brown with a chalky blue covering. The average egg from mature female weighs about 10 grams (1/3 ounce), about 8 % of the body weight of the quail hen as compared to 3 percent for chicken eggs (Shim, 2015). The egg of Japanese quail contains 158 Cal. of energy, 74.6% water, 13.1% protein, 11.2% fat, and 1.1% total ash. The mineral content includes 0.59 mg calcium, 220 mg phosphorus and 3.8 mg iron. The vitamin content is 300 i.u. of vitamin A, 0.12 mg of vitamin B1, 0.85 mg of vitamin B2 and 0.10 mg nicotinic acid (Shim, 2015).

2.2 THEORY AND CONCEPT OF PRODUCTION

2.2.1 Theory of Production

The growing of wheat, rice or any other agricultural crop by farmers or any other industrial product is often referred to as production. Debertin (2012), describe production as the economic process of converting inputs into outputs. Production uses resources to create a good or service that is suitable for use, gift-giving in a gift economy, or exchange in a market economy. This can include manufacturing, construction, storing, shipping, and packaging. Some economists define production broadly as all economic activity other than consumption. They see every commercial activity other than the final purchase as some form of production.

Production is a process, and as such it occurs through time and space. Because it is a flow concept, production is measured as a “rate of output per period of time”. There are three aspects to production processes:

1. the quantity of the good or service produced,
2. the form of the good or service created,
3. the temporal and spatial distribution of the good or service produced.

Production is a process that combines various material inputs and immaterial inputs (plans, know-how) to make something for consumption (the output). It is the act of creating output, a good or service that has value and contributes to the utility of individuals (Debertin, 2012).

According to Hall (2017), the theory of production concerns what firms use to allocate inputs so the quantity of goods (output) is optimized, maximizing profits.

The mainstream economic theory assumes that firms seek to maximize profits. Production theory, then, asks what combination of inputs (known as factors of production) will generate the quantity of output that yields maximum profit.

Factors of production include land, labor and capital. The latter category consists of a firm’s facilities, machinery and other goods used in the production process.

Some economists group factors of production into more specific categories. These categories include land, capital goods, raw materials, human capital (labour), and entrepreneurship.

A production process is efficient if the resulting quantity of output is the highest level possible. It is inefficient if fewer factors can produce the same quantity of goods.

Economists use a mathematical equation model known as a production function to study production empirically. The production function models output as a function of various levels of inputs (Hall, 2017).

2.2.2 Concept of Production

Production can be described as the transformation of input into output. In strict economic sense, production is more than putting things together; it is concerned with whole process of making good and services available to the consumers. Goods and services that are demanded and supplied are produced by transforming other goods and services called into those goods which are usually called output or products. The process of transforming inputs into output is called production.

Adegeye and Ditto (1985), explained that there is nothing that is permanently an output or an input. What some body considers as his output could be another person's input. A maize farmer for example, produces maize from his land using labour and his skills as a farmer. His inputs are land, labour, capital (his hoe and cutlasses) and his skills. His output is maize. For poultry feed mill however, the maize (the output in the earlier case) is one the inputs, while poultry feed will be the output will be output. For a poultry farmer, on the other hand the feed is one of his inputs, while eggs or chicken (poultry meat) or both are his outputs.

Debertin (2012), expressed that agricultural production economics is concerned primarily with economic theory as it relates to the producer of agricultural commodities. Production is the process of changing goods or services into different ones that have more utility or value to the society than the goods used in the process and the newly created goods are called products. Production economics is based on the principles of optimization, which is output maximization and cost minimization (Olukosi & Ogunbible, 1989) and further explained that the basic concept of the firm and the principles of resource allocation are core of agricultural production economics.

Agricultural productivity is the index of the ratio of total output to input used in the production process which is synonymous with resource use productivity. The computation of this important productivity statistics can be achieved from analysis of production functions. Such productivity statistics include the Average Product (AP) which is the ratio of output to inputs; that is $AP = y/x$ for any level of input use (x). Marginal Product (MP) refers to the change in output associated with an incremental change in the use of an input; usually taken to be 1 unit. Marginal Rate of Substitution (MRS) between a pair of inputs is equal to the negative ratio of the marginal products algebraically as $MRS_{x_2x_1} = -MPP_{x_2}/MPP_{x_1}$. Elasticity of Production (EP) is the percentage change in output divided by percentage in inputs, as the level of input is changed, and Return to Scale (RTS) is the quantitative change in output of a firm resulting from a proportionate increase in all inputs. The analyses have made the delineation of three economic stages of production function that enable us to know the point of efficient utilization of resources in the production process possible (Taphee, 2015).

2.3 THEORY AND CONCEPT OF PRODUCTION FUNCTION

2.3.1 Theory of Production Function

Gradestack (2017) described production function as the relationship between input and output expressed in the form of a mathematical equation. It states the maximum amount of output that can be produced with the given amount of inputs or minimum inputs needed to produce a given quantity of output. Inputs refer to the factor services which are used in production i.e. land, labour, capital and enterprise. Output refers to the volume of goods produced. The production function is given as:

$$Q = f(L_1, L_2, K, O) \text{ -----1}$$

where;

Q = Quantity produced

L1 = Land

L2 = Labour

K = Capital

O = Organization

The production function can be classified into two.

- 1 **Short run production function:** Short run is a period of time which is too short for a firm to install a new capital equipment to increase production. In the short run, production will increase when more units of variable factors are used with fixed factors. In short run, at least one factor is fixed. Short run production function is known as “Law of Variable Proportions”. Factors are divided into two parts. Namely: -
 - a. **Fixed inputs** are those factors, the quantity of which remains constant irrespective of the level of output produced by a firm. For example, land, building, etc.
 - b. **Variable inputs** are those factors, the quantity of which varies (only to a limited extent) with variations in the levels of output produced by a firm. For example, wages, power, working hours of the labourers, etc.
- 2 **Long run production function:** Long run is a period of time in which all the factors of production are variable. Long run production function is known as the “law of returns to scale” (Gradestack, 2017).

Another production function is the Frontier Production Function which was later developed to cater for the short comings of the above functions.

Stochastic frontier production function

A Stochastic Production Function is defined by Battese (1991) as

$$Y_i = f(x_i; \beta) \exp(V_i - U_i), \quad i = 1, 2, \dots, N, \quad \text{-----}2$$

where; Y_i is output of the i^{th} farm, X_i is the vector of input quantities used by the i^{th} farm, β is a vector of unknown parameters to be estimated, $f(\cdot)$ represents an appropriate function (e.g., Cobb – Douglas, translog, etc). The term V_i is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer e.g., weather, disease outbreaks, measurement errors etc, while the term U_i is a non-negative random variable representing inefficiency in production relative to the stochastic frontier. The random error V_i is assumed to be independently and identically distributed as $N(\delta, \delta_i^2)$ random variables independent of the U_i which are assumed to be non-negative truncations of the $N(0, \delta_i^2)$ distribution. (i.e., half – normal distribution) or have exponential distribution. The technical efficiency of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology.

$$TE_i = \exp(-U_i), \quad \text{-----}3$$

i.e., $TE_i = Y_i/Y_i^*$

$$\begin{aligned} &= f(x_i; \beta) \exp(V_i - U_i) / f(x_i; \beta) \exp(V_i) \\ &= \exp(-U_i). \end{aligned}$$

where; Y_i is the observed output and Y_i^* is the frontier output.

The parameters of the stochastic production frontier function were estimated using the Maximum Likelihood Method (MLE) (Adedeji, Adelalu, Ogunjumi & Otukunrin, (2013). Technical efficiency is based on expressing the maximum amount of output obtainable from given bundles of production resources with fixed technology.

Allocative efficiency on the other hand relates to the degree to which a farmer utilizes inputs in optimal proportions, given the observed input prices.

Economic efficiency refers to the choice of the best combination for a particular level of output which is determined by both input and output prices. It is the product of technical and allocative efficiency ratios (Girei *et al.*, 2013).

2.3.2 Concept of Production Function

In a production process, inputs are converted into outputs. What is put into production process comes out either as a product or in form of waste. A function states the relationship between variables. Therefore, production function is the physical relationship between the output and inputs used in the production of product (Olukosi & Ogungbile, 1989). According to Abubakar (2006), estimation of input and output relationship involves the specification of a production function that depicts the factor-product relation. Hence, production function is the physical relationship between the inputs and the outputs.

According to Adegeye and Ditto (1985), production function can be studied under four main headings. Firstly, we assume that we are interested in only one output and that only one variable input like labour is used to produce the single output; this is the case of factor – product relationship. Secondly, we can assume that we want to produce a single output but two of the factors used in producing the output are variable factors while all others are constant; this is the case of factor-factor relationship. Thirdly, we can think of one variable factor such as labour (with fixed inputs) being used to produce two commodities; this is the case of product - product relationship. Finally, we can assume that we are interested in producing many products using many variable inputs; this is the case of many factors – many products relationship.

Factor – Product production function can be expressed as: $Q = F(x_1|x_2, \dots, x_n)$ or $Q = F(x_1)$. where; Q is the quantity of output, x_1 is the quantity of variable input used, x_2, \dots, x_n are fixed inputs.

A Factor-Factor production function can be written as: $Q = F(x_1, x_2|x_3, \dots, x_n)$ or $Q = F(x_1, x_2)$. Where Q is the output, x_1 and x_2 are the variable inputs and x_3, \dots, x_n are fixed inputs (Adegeye & Ditto, 1985).

Production function refers to the relationship between the input of factor services and the output of the resultant product. The production function is based on the idea that the amount of output in a production process depends upon the amount of inputs used in the process (Aditya, 2016) and further explained that output depends upon an input or a set of inputs in such a way that there is one unique amount of output resulting from each set of inputs. This unique relationship between output and inputs is termed as production function with general model as:

$$Y = f(x_1, x_2, x_3, x_4, x_5) + U \text{-----}4$$

The forms of the functions include:

1. The linear functional form specified as:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + u \text{-----}5$$

2. Cobb-Douglas functional form:

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}e^u \text{-----}6$$

Logarithmic transformation of the model would be:

$$\log Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + u \text{-----}7$$

3. Semi-log functional form:

$$Y = a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + u \text{-----}8$$

4. Exponential functional form:

$$Y = e^{a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+u} \text{-----}9$$

(Olukosi & Ogunbile, 1989).

According to Chand (2016), the production function is the central part of production theory and as such there is a theoretical interest in its estimates. Economists are often involved in describing activity at the level of a firm or industry or the economy as a whole by the approach of production function. The followings are the four most common production functions:

1. Linear homogeneous production function

When all the inputs are increased in the same proportion, the production function is said to be homogeneous. The degree of production function is equal to one. This is known as linear homogeneous production function. In order to estimate the production function, it is necessary to express the function in explicit functional form. Mathematically, this form of production function is expressed as

$$nQ = f(nL, nK) \text{-----}10$$

This production function also implies constant returns to scale. That is if L and K are increased by n-fold, the output Q also increases by n-fold. This form of production function is a well-behaved production function; as the relative factor prices remain constant, farmer does have to make any fresh decision regarding factor proportions to be used, as he expands his level of production. Moreover, this feature of the same optimum factor proportions is also very useful in input- output analysis.

2. Cobb-Douglas production function

Charles W. Cobb and Paul H. Douglas in 1927 studied the relationship of inputs and outputs and formed an empirical production function, popularly known as Cobb-Douglas production function.

The Cobb-Douglas production function is expressed by

$$Q = AL^\alpha K^\beta \text{-----}11$$

where; Q is output and L and K are inputs of labour and capital respectively. A, α and β are positive parameters where $\alpha > 0$, $\beta > 0$. The equation indicates that the output depends directly on L and K and that part of output which cannot be explained by L and K is explained by A which is the ‘residual’, often called technical change.

The marginal products of labour and capital are the functions of the parameters A, α and β and the ratios of labour and capital inputs. That is,

$$MP_L = \partial Q / \partial L = \alpha A L^{\alpha-1} K^\beta \text{-----12}$$

$$MP_K = \partial Q / \partial K = \beta A L^\alpha K^{\beta-1} \text{-----13}$$

The two parameters A and P taken together measure the degree of the homogeneity of the function.

In other words, this function characterises the returns to scale thus:

$\alpha + \beta > 1$: Increasing returns to scale

$\alpha + \beta = 1$: Constant returns to scale

$\alpha + \beta < 1$: Decreasing returns to scale.

Although the C-D production function is a multiplicative type and is non-linear in its general form, it can be transferred into linear function by taking it in its logarithmic form. That is why, this function is also known as log linear function, which is

$$\text{Log } Q = \log A + \alpha \log L + \beta \log K \text{-----14}$$

It is easier to compute C-D function when expressed in log linear form.

3. Constant elasticity of substitution production function

The Constant Elasticity Substitution (CES) production function is otherwise known as Homothetic production function. Arrow, Chenery, Minhas and Solow in 1961 have developed the Constant Elasticity of Substitution (CES) function. This function consists of three variables Q, K and L, and three parameters A, α and θ . It may be expressed in the form

$$Q = A [\alpha C^{-\theta} + (1 - \alpha) L^{-\theta}]^{-1/\theta} \text{-----15}$$

where; Q is the total output, K is capital, and L is labour. A is the efficiency parameter indicating the state of technology and organisational aspects of production. It shows that with technological and/or organisational changes, the efficiency parameter leads to a shift in the production function, α (alpha) is the distribution parameter or capital intensity factor coefficient concerned with the relative factor shares in the total output, and θ (theta) is the substitution parameter which determines the elasticity of substitution. And $A > 0$; $0 < \alpha < 1$; $\theta > -1$.

In the CES production function, the elasticity substitution is constant and not necessarily equal to unity.

4. Variable elasticity substitution production function

Recently attempts have been made to get a new production function. The resulting production function is the generalisation of CES which possesses the desirable properties of variable elasticity substitution.

Lu and Fletcher in 1968 filled a logarithmic relationship containing the wage rate (W) as well as the capital-labour ratio (K/L) to explain value added per unit of labour.

$$V/L = a + b \log W + c \log K/L \text{-----16}$$

where;

V = Value added

W = Wage rate

K = Capital

L = Labour

a, b and c are the parameters to be estimated.

The elasticity of substitution (σ) is

$$\sigma = b/1-c (1+WL/rk) \text{-----17}$$

where; W_L and r_k are the shares of labour and capital respectively (Chand, 2016).

2.4 THEORY AND CONCEPT OF PRODUCTION EFFICIENCY

2.4.1 Theory of Production Efficiency

Production efficiency is an economic level at which the economy can no longer produce additional amounts of a good without lowering the production level of another product. This happens when an economy is operating along its production possibility frontier. Efficient production is achieved when a product is created at its lowest average total cost; production efficiency measures whether the economy is producing as much as possible without wasting precious resources.

Theoretically, production efficiency includes all of the points along the production possibility frontier, but this is difficult to measure in practice. If the economy cannot make more of a good without sacrificing the production of another, then a maximum level of production has been reached.

Production efficiency is based on a business' ability to produce the highest number of units of a good while using the least amount of resources possible. The aim is to find a balance between the use of resources, rate of production and quality of the goods being produced. When production efficiency has been reached, it is not possible to produce more goods without using excess resources or sacrificing product quality (Investopedia, 2017).

2.4.2 Concept of Production Efficiency

Efficiency analysis is an issue of interest given that the overall productivity of an economic system is directly related to the efficiency of production of the component within the system. Thus, the concept of efficiency becomes a central issue in production economics. The analysis of efficiency is generally associated with the possibility of firm producing a certain optimal level of output from a given bundle of

resources or certain level of output at a least cost. The analysis falls into two categories: Parametric and Nonparametric. The parametric approach relies on a parametric specification of the production function while the non-parametric imposes a non-parametric restriction to the underlying technology (Taphee, 2015).

The comparison can be in the form of the ratio of observed to maximum potential output obtainable from the given input or the ratio of minimum potential to observed input required to produce the given output or the combination of the two. In these two comparisons, the optimum is defined in terms of production possibilities, while efficiency is technical. It is also possible to define the optimum in terms of the behavioral goal of the production unit. In this case efficiency is economic and is measured by comparing observed and optimum cost, revenue, profit or whatever the production unit assumes to pursue, subject to the appropriate constraints on qualities and prices (Battese, 1991).

Technical efficiency (TE)

Technical Efficiency (TE) is the achievement of maximum potential output from a given quantity of input under a given technology. It is a major component of productivity being used in measuring farm performance. It is used to measure the ability of a farm to obtain maximum output from a given set of inputs (Rahman, 2013). According to Olasunkanmi *et al.* (2006), there are two basic methods of measuring technical efficiency which are the Classical and Frontier Approaches. Classical approach is based on the ratio of input and output which is also described as partial productivity measure because it compares the output with one input at a time. Frontier approach came about as result of the short comings of the classical approach, it analyses technical efficiency and related issues.

Allocative efficiency (AE)

Allocative efficiency has to do with the extent to which farmers make efficient decision by using inputs up to the level at which their marginal contribution value is equal to the factor cost ($MVP = MFC$) (Taphee, 2015). It reflects the ability of a farm to use inputs in optimal proportions given their respective prices and the production technology (Rahman, 2013).

Economic efficiency (EE)

Economic efficiency combines both the technical and allocative efficiency. It is derived from product of the technical and allocative efficiency (that is, Technical efficiency x Allocative efficiency). Economic efficiency is concerned with the realization of maximum output in monetary term with the minimum available resources (Rahman, 2014). It is possible for a farm to have either technical or allocative efficiency without having economic efficiency. The reason may be that the farmer, in this case, is unable to make efficient decisions as far as the use of inputs is concerned. In some cases, a farmer might fail to equate marginal input cost to marginal value of product. If technical and allocative efficiency occur together, they are both necessary and sufficient conditions for economic efficiency. This assumes that the farmer has made right decision to minimize costs and maximize profits implying operating on the profit frontier (Rahman, 2013).

2.5 FRONTIER PRODUCTION FUNCTION

2.5.1 Stochastic Frontier Production Function

The Stochastic frontier production function according to Rahman (2013), assumed that a random sample of farms is observed over T period such that the production of the N farms over time is a function of given input variables and random variable which involve the traditional random error and non-negative random variables which

are associated with technical inefficiencies of production. For a given combination of input levels, it is assumed that the realized production of a farm is bounded above by the sum of a parametric function of known inputs, involving unknown parameters, and a random error, associated with measurement error of the level of production or other factors, such as the effects of weather, strikes, damaged product etc. The greater the amount by which the realized production falls short of this stochastic frontier production, the greater the level of technical inefficiency (Rahman, 2013). An appropriate stochastic formulation is:

$$y_i = f(x_i) TE_i \cdot e^{v_i} \text{-----} 18$$

where; y_i is the output, x_i is input, TE denotes technical efficiency and v_i is unrestricted. The latter term embodies measurement errors, any other statistical noise, and random variation of the frontier across farms. The reformulated model is

$$\ln y_i = \alpha + \beta x_i + v_i - u_i \text{-----} 19$$

$u_i > 0$, but v_i may take any value. A symmetric distribution, such as the normal distribution, is usually assumed for v_i . Thus, the stochastic frontier is $= \alpha + \beta x_i + v_i$ and u_i represents the inefficiency.

a. Stochastic frontier cost function

Specification of cost function involves alteration of error term from $(V_i - U_i)$ to $(V_i + U_i)$. For example, this substitution would transform the production function into cost function: $Y_i = X_i \beta (v_i + u_i)$, $i = 1 \dots N$ where; y_i is the cost of production of the i^{th} farm; X_i is a $k \times 1$ vector input prices and output of the i^{th} farm;

β is a vector of unknown parameters The v_i are random variables which are assumed to be iid $N(0, \delta_v^2)$ and independent of the u_i which are nonnegative random variables which account for the cost inefficiency in production, often assumed to be iid/ $N(0,$

δ_u^2), in this cost function the u now defines how far the firm operates above the cost frontier.

b. Stochastic frontier profit function

This can be specified as: $\pi_i = f(p_i, z_i) \exp(\varepsilon_i)$ -----20

where; π_i is the normalized profit for i^{th} farm obtained as profit divided by the price of output. p_i , represents price of i^{th} variable inputs divided by output price and z_i is the fixed factor used by i^{th} farm. The error term is composed of two components:

$$\varepsilon_i = v_i - u_i$$

where; v_i is normally, independently and identically distributed [i.e., $v_i \sim N(0, \delta_v^2)$] two sided error term representing various random shocks and effects of measurement error of variables. The other component u_i is the non-negative or one-sided residual representing farm-specific profit inefficiency. Hence if $u_i = 0$, the farm's profit inefficiency is nonexistent, i.e., the farm makes maximum possible profit (being on the frontier) given its input prices and fixed factors. Conversely, $u_i > 0$ indicates that the farm forgoes profit due to inefficiency (Rahman, 2013).

2.5.2 Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric, which uses mathematical programming methods. Programming methods can simply handle disaggregated inputs and multiple output technologies. Being non-stochastic, the DEA approach does not differentiate data noise and inefficiency (Rahman, 2013). The DEA method is a frontier method that does not require specification of a functional or distributional form, and can accommodate scale issues. The data envelopment analysis technique uses linear programming methods to construct a non-parametric frontier. The technique also identifies efficient production units, which belong to the frontier, and inefficient ones, which remain as follows:

The DEA problem can be expressed in the envelopment form. The formulation of this model is specified as follows:

Consider a set of N homogenous decision-making units (DMU) employing ‘m’ inputs $X_i = (X_{1i} \dots X_{mi})$ (inputs) to obtain ‘s’ outputs $Y_i = (Y_{1i} \dots Y_{si})$. Each pair of vectors (X_i, Y_i) constitutes a productive process of each DMU, and then the following linear programme needs to be solved.

$$X_{ji} \theta_0^g - \sum_{i=1}^n x_{ji} \lambda_i \geq 0, j = 1 \dots m \dots \dots \dots 21$$

$$- y_{ri} \theta_0^g + \sum_{i=1}^n y_{ri} \lambda_i \geq 0, r = 1 \dots s \dots \dots \dots 22$$

$$\lambda_i \geq 0, A_i$$

Where the objective function θ_0^g is a scalar that represents the minimum level to which the use of inputs can be reduced without altering the output level. It is the global technical efficiency score (GTE) for the DMU. If this index is equal to one, the production unit is considered technically efficient. If it is less than one there is some degree of technical inefficiency. θ_0^g index equal to one ensures that the use of all inputs cannot be reduced at the same time, although a variation in the use of one of them may improve efficiency. A further condition to guarantee technical efficiency is that the slack variables equal zero.

λ_i ($i= 1, 2, \dots, n$) are constants that represent the weights to be used as multipliers for the input levels of a reference production unit to indicate the input levels that an inefficient unit should achieve efficiency. The scalar θ_0^g is the estimated measure of technical efficiency for the analyzed production unit. The DEA efficiency evaluation of DMU is conducted by reference to solutions that do not exhibit reductions in any of their outputs or increases in any of their inputs (Rahman, 2013).

2.6 DISEASES OF QUAIL AND CHICKEN

Like other avian species quails are also affected by natural diseases manifesting in various kind of symptoms. Mohammed and Ejiofor (2015) described the following common Bacterial, Viral, Protozoans, Fungal and Ectoparasitic diseases of Quail:

2.6.1 Bacterial Diseases

Bordetellosis: This is an upper respiratory disease, primarily seen in young quails, caused by infection with *Bordetella avium*. The disease is characterized by sneezing, oculonasal discharge, mouth breathing, tracheal collapse, and stunted growth.

Fowl cholera: This is a disease of many avian species caused by infection with *Pasteurella multocida* (PM). PM is capable of multiplication in the bloodstream of a bird. As a result of this bacteremia, the organism may quickly colonize many organs, contributing to the typical purulent exudative lesions of fowl cholera seen in the joints, wattles, ovaries, brain, liver, spleen, and lungs

Mycoplasma meleagridis (MM): This is introduced into a flock by contaminated equipment, shoes etc. The disease is characterised by drop in egg production and hatchability in breeder flocks. High mortality, unthriftiness, respiratory distress, stunting, crooked neck with deformity of cervical vertebrae, and leg deformation are common in young birds.

Fowl typhoid (FT): This disease is transmitted by *Salmonella enterica* serovar *Gallinarum*, a non-motile host. FT is a severe systemic disease responsible for heavy economic losses in commercial poultry industry through morbidity, mortality and pathological lesions.

Colibacillosis: This disease is generally seen in aged quails. It is caused by a bacterium called *Escherichia coli*, which is a gram negative, rod-shaped bacterium

found normally in the intestine of the bird. The disease is characterised by difficulty to walk, loss of appetite and epilepsy are the symptoms of this disease.

Staphylococcal infection: This infection is caused by Staphylococcal bacteria entering the body of quails through wounds in the body. The infected wound will grow into a blister. Even though this is not an acute disease, it affects the productivity of quails.

2.6.2 Viral Diseases

Egg drop syndrome -76 (EDS-76): This is a recognized disease of chickens and Japanese quails, which is of high economic importance because the birds do not become ill. The disease caused by duck adenovirus A and transmitted vertically in eggs; is characterised by decrease in production, fertility and hatchability of eggs.

Fowl pox (FP) / chicken pox/sore head/avian diphtheria: This disease is transmitted by direct contact between infected and susceptible birds or by mosquitoes. Virus-containing scabs also can be sloughed from affected birds and serve as a source of infection. FP is manifested by wart-like lesions on un-feathered areas (head, legs, vent, etc.) (Dry form) and canker like lesions in the mouth, pharynx, larynx, and trachea (wet form).

Infectious bronchitis (quail bronchitis) / (IB): IB is a very contagious viral disease. The disease is spread by air, feed bags, infected dead birds, infected houses, and rodents. The virus can be egg-transmitted; however, affected embryos usually will not hatch. The severity of infectious bronchitis infection is influenced by the age and immune status of the flock, by environmental conditions, and by the presence of other diseases. Affected birds will be chirping, with a watery discharge from the eyes and nostrils, and laboured breathing with some gasping in young chickens. The infectious

bronchitis virus infects many tissues of the body, including the reproductive tract. Eggshells become rough and the egg white becomes watery.

New castle diseases (ND): Newcastle disease affects all birds of all ages. There are three forms of Newcastle disease, mildly pathogenic (lentogenic), moderately pathogenic (mesogenic) and highly pathogenic (velogenic). Newcastle disease is characterized by a sudden onset of clinical signs which include hoarse chirps (in chicks), watery discharge from nostrils, labored breathing (gasping), facial swelling, paralysis, trembling, and twisting of the neck (sign of central nervous system involvement). In adult laying birds, symptoms include; decreased feed and water consumption and a sharp drop in egg production. The Newcastle virus can be transmitted through airborne route or introduced on contaminated shoes, poultry caretakers, feed deliverers, farm visitors, car tires, dirty poultry equipment, feed sacks, egg crates, and wild birds.

2.6.3 Protozoan Diseases

Coccidiosis: This is considered an important disease because endogenous stages of the parasites and a high number of oocysts in feces were associated with intestinal lesions. This disease is transmitted by 3 *Eimeria* species (*E. tsunodai*, *E. uzura* and *E. bateri*).

2.3.4 Fungal Diseases

Aspergillosis: Aspergillosis or brooder pneumonia is a fungal infection seen especially in quail chicks. This infection is caused by a fungal organism called *Aspergillus fumigatus*. These organisms grow readily in wet food, wet litter, wet or rotten wood etc. The chicks get infected by contaminated food, unclean water and contaminated air. Major symptoms include sleeplessness, breathing problem, and loss of appetite, convulsions and sometimes results in death.

Candidiasis: This is also a fungal infection caused by fungal organisms of Candida family. Sore can be seen inside mouth and respiratory tracts of infected birds.

Aflatoxicosis: This disease is caused by a fungal organism called Aflatoxin. These fungal organisms grow readily in wet and old food. Aflatoxin is transmitted the body of quail through hatchery and contaminated food. The disease is characterised by loss of appetite, fatigue, silent gasping or gurgling sounds, mortality.

2.6.5 Ectoparasites

Lousiness: Lice infestation constitutes the common ectoparasitism of Japanese quails. The lice commonly recovered from quails include, Menacanthus spp, Lipeurus spp, Gonoides spp. Lousiness only becomes a problem when the number is high. The disease is characterized by irritation, anorexia, pale mucous membrane, loss in production and reduced egg production. The lesions found were plucking dermatitis, skin irritation, and mild to moderate (Mohammed and Ejiofor, 2015).

2.7 THEORY AND CONCEPT OF MARKETING

2.7.1 Theory of Marketing - The Marketing Mix

According to Professional Academy (2017) Marketing Mix is a tool used by businesses and Marketers to help determine a product or brands offering. The 4 P's have been associated with the Marketing Mix since their creation by E. Jerome McCarthy in 1960.

The Marketing Mix 4 P's:

- 1 **Product:** The Product should fit the task consumers want it for, it should work and it should be what the consumers are expecting to get.
- 2 **Price:** The Product should always be seen as representing good value for money. This does not necessarily mean it should be the cheapest available; one of the main tenets of the marketing concept is that customers are

usually happy to pay a little more for something that works really well for them.

- 3 Place:** The product should be available from where your target consumer finds it easiest to shop. This may be high street, mail order or the more current option via e-commerce or an online shop.
- 4 Promotion:** Advertising, Sales Promotion, Personal Selling and, in more recent times, Social Media are all key communication tools for an organisation. These tools should be used to put across the organisation's message to the correct audiences in the manner they would most like to hear, whether it be informative or appealing to their emotions.

In the late 70's it was widely acknowledged by Marketers that the Marketing Mix should be updated. This led to the creation of the Extended Marketing Mix in 1981 by Booms & Bitner which added 3 new elements to the 4 P's Principle. This now allowed the extended Marketing Mix to include products that are services and not just physical things.

The extended 7 P's:

- 5 People:** All companies are reliant on the people who run them from front line Sales staff to the Managing Director. Having the right people is essential because they are as much a part of your business offering as the products/services you are offering.
- 6 Processes:** The delivery of your service is usually done with the customer present so how the service is delivered is once again part of what the consumer is paying for.
- 7 Physical evidence:** Almost all services include some physical elements even if the bulk of what the consumer is paying for is intangible. For

example, a hair salon would provide their client with a completed hairdo and an insurance company would give their customers some form of printed material.

Though in place since the 1980's, the 7 P's are still widely taught due to their fundamental logic being sound in the marketing environment and marketers' abilities to adapt the Marketing Mix to include changes in communications such as social media, updates in the places which you can sell a product/service or customers' expectations in a constantly changing commercial environment.

In some spheres of thinking, there are 8 P's in the Marketing Mix. The final P is Productivity and Quality.

The 8th P of the Marketing Mix:

8 Productivity and quality - This P asks "is what you're offering your customer a good deal?" This is less about you as a business improving your own productivity for cost management, and more about how your company passes this onto its customers.

Even after 31 years (or 54 in the case of the original P's), the Marketing Mix is still very much applicable to a marketer's day to day work. A good marketer will learn to adapt the theory to fit with not only modern times but their individual business model (Professional academy, 2017).

2.7.2 Concept of Marketing

Kotler (2000) described five Marketing Concepts:

The production concept: This concept is the oldest of the concepts in business. It holds that consumers will prefer products that are widely available and inexpensive. Managers focusing on this concept concentrate on achieving high production efficiency, low costs, and mass distribution. They assume that consumers are

primarily interested in product availability and low prices. This orientation makes sense in developing countries, where consumers are more interested in obtaining the product than in its features.

The product concept: This orientation holds that consumers will favor those products that offer the most quality, performance, or innovative features. Managers focusing on this concept concentrate on making superior products and improving them over time. They assume that buyers admire well-made products and can appraise quality and performance. However, these managers are sometimes caught up in a love affair with their product and do not realize what the market needs.

The selling concept: This is another common business orientation. It holds that consumers and businesses, if left alone, will ordinarily not buy enough of the selling company's products. The organization must, therefore, undertake an aggressive selling and promotion effort. This concept assumes that consumers typically show buying inertia or resistance and must be coaxed into buying. It also assumes that the company has a whole battery of effective selling and promotional tools to stimulate more buying. Most firms practice the selling concept when they have overcapacity. Their aim is to sell what they make rather than make what the market wants.

The marketing concept: This is a business philosophy that challenges the above three business orientations. Its central tenets crystallized in the 1950s. It holds that the key to achieving goals of the selling company consists of the company being more effective than competitors in creating, delivering, and communicating customer value to its selected target customers. The marketing concept rests on four pillars: target market, customer needs, integrated marketing and profitability.

The societal marketing concept: This concept holds that the organization's task is to determine the needs, wants, and interests of target markets and to deliver the desired

satisfactions more effectively and efficiently than competitors (this is the original marketing concept). Additionally, it holds that this all must be done in a way that preserves or enhances the consumer's and the society's well-being.

Olukosi, Isitor and Ode (2005) defined agricultural marketing as the performance of all activities which direct the flow of goods and services to the consumer from the producers (farmers) in order to accomplish the farmer's objectives. Many people consider marketing as equivalent to selling or transferring the product to another person for a price. Selling is central on the micro concept of marketing but it is only part of it. According to Olukosi, Isitor and Ode (2005) marketing includes packaging, storage, transportation, pricing, financing, risk bearing and even product design. They also observed that agricultural marketing involves all those physical, legal and economic services, which are necessary to make products from the farm available to the consumers. Thus, creating of form, place, time, and possession utilities is derived from agricultural marketing.

Marketing is about identifying and meeting human and social needs. In a nutshell marketing is defined as "meeting needs profitably" (Kotler & Keller, 2009), Marketing is the social process by which individuals and groups obtain what they need and want through creating and exchanging products and value with others. Marketing in the words of Asogwa and Okwoche (2012) is a process of satisfying human needs by bringing products to people in the proper form and at a proper time and place. Marketing has economic value because it gives form, time, place, utility to products and services. The marketing of agricultural products begins at the farm when the farmer harvests his products. Onwudinjo, Eze and Nzekwe (2013) reported that marketing of agricultural outputs includes all activities involved in identification,

conceptualization and the flow of agricultural products and services from the point of initial production until they reached the final the point of consumption.

After production, every farmer is faced with the problem of selling the farm produce. Once the market is found, the producer will prepare what will enhance the flow of the farm outputs to the final consumers; because farm produce usually passes through series of markets and middlemen before it gets to the final consumers. Getting customers to purchase the service or product is the purpose of marketing (Onwudinjo, *et al.*, 2013).

2.8 THEORY OF MARKET STRUCTURE AND CONDUCT

2.8.1 Theory of Market Structure

Market structure refers to the nature and degree of competition in the market for goods and services. The structures of market both for goods market and service (factor) market are determined by the nature of competition prevailing in a particular market. There are a number of determinants of market structure for a particular good; they are:

- (a) The number and nature of sellers,
- (b) The number and nature of buyers,
- (c) The nature of the product,
- (d) The conditions of entry into and exit from the market and
- (e) Economies of scale (Chand, 2014).

Depending on the degree of competition forms of market structures exist.

Forms of market structure:

1. **Perfect competition:** Many firms, freedom of entry, homogeneous product, normal profit.

2. **Monopoly:** One firm dominates the market, barriers to entry, possibly supernormal profit.
3. **Oligopoly:** An industry dominated by a few firms, e.g. 5 firm concentration ratios of > 50%. Interdependence of firms
4. **Monopolistic competition:** Freedom of entry and exit, but firms has differentiated products. Likelihood of normal profits in the long term.
5. **Contestable markets:** An industry with freedom of entry and exit, low sunk costs. The theory of contestability suggests the number of firms is not so important, but the threat of competition (Pettinger, 2016).

2.8.2 Theory of Market Conduct

Market conduct refers to the pattern of behavior followed by firms in adopting or adjusting to the markets in which they sell or buy. It is the way in which buyers and sellers behave both amongst themselves and amongst each other. Market conduct comprises several methods practiced by traders to attract the customers to the business. It includes several price competition methods and non-price inducements

2.9 CONCEPT OF MARKET STRUCTURE AND CONDUCT

2.9.1 Concept of Market Structure

Market is a set of buyers and sellers, whose interactions are both real and potential, determine the price of a set of goods. The concept of a market structure is therefore understood as those characteristics of a market that influence the behaviour of the firms working in that market. The main aspects that determine market structures are: the number of agents in the market, both sellers and buyers; their relative negotiation strength, in terms of ability to set prices; the degree of concentration among them; the degree of differentiation and uniqueness of products; and the ease, or not, of entering

and exiting the market. The interaction and differences between these aspects allow for the existence of several market structures (Torbert, 2012).

According to Riley (2015), market structure is best defined as the organizational and other characteristics of a market, that focus on those characteristics which affect the nature of competition and pricing. Traditionally, the most important features of market structure are:

The number of firms (including the scale and extent of foreign competition)

The market share of the largest firms (measured by the concentration ratio)

The nature of costs (including the potential for firms to exploit economies of scale and also the presence of sunk costs which affects market contestability in the long term)

The degree to which the industry is vertically integrated - vertical integration explains the process by which different stages in production and distribution of a product are under the ownership and control of a single enterprise.

The extent of product differentiation (which affects cross-price elasticity of demand)

The structure of buyers in the industry (including the possibility of monopsony power)

The turnover of customers (sometimes known as "market churn"), that is how many customers are prepared to switch their supplier over a given time period when market conditions change.

2.9.2 Concept of Market Conduct

Market conduct means the manners in which market agents behaves with regard to price determination, sales promotion tactics and the regulatory activities of government. If market agents determine prices on the basis of some secret or illegal

cooperation or conspiracy, it may lead to an inefficient, non-integrated market. Regulatory actions of government also determine the market conduct and thus market integration. Government restriction and regulation obstructs dissemination of market information and it can lead to distorted price determination by the economic agents. This ultimately accommodates an inefficient and non-integrated market. On the other hand, the behavior of economic agents in an economy which is liberated from controls will be conducive for an efficient and well-integrated market. It comprises of various decision-making techniques in determining price, output, sales promotion policies and other tactics to achieve their economic goals. Thus, given the structure of the market, market conduct determines the outcome.

2.10 THEORY OF PROFIT - THE DYNAMIC THEORY OF PROFIT

Shaikh (2016) reported that Prof. J. B Clark propounded this theory in the year 1900. According to him—” *Profit is the difference between the price and the cost of the production of the commodity*”. But Profit is the result of dynamic change. Further, Prof. Clark was of this opinion that in a stationary state having static economic conditions of demand and supply, there can be no real or pure profit as a surplus. In a stationary economy, the quantum of capital invested, methods of production, managerial organisation, technology, demand pattern etc. remain constant.

Under competitive conditions, price tends to equal average costs; hence, the surplus is zero. So, no pure profit but there may be some frictional profits emerging due to frictions in the system. But this cannot be regarded as real Profits.

Profit is the result exclusively of six dynamic changes:

- (1) Changes or increase in population,
- (2) Changes in tastes and preferences,
- (3) Multiplication of wants,

- (4) Capital formation,
- (5) Technological advancement and
- (6) Changes in the form of business organisation.

On account of these changes the economy tends to be dynamic. Demand and supply conditions are altered. Some entrepreneurs may get advantageous business positions against others and may reap surplus over costs, as a real profit. In short, those who take advantage of changing situation can earn real profits according to their efficiency (Shaikh, 2016).

2.11 CONCEPT OF PROFITABILITY

According to Trivedi (2010), profitability is described as the ability to earn profit from business activities of an organization, firm, or an enterprise. It shows how efficiently the management can make profit by using all the resources available in the market.

Profitability is an index of efficiency; and is regarded as a measure of efficiency and management guide to greater efficiency. Though, profitability is an important yardstick for measuring the efficiency, the extent of profitability cannot be taken as a final proof of efficiency. Sometimes satisfactory profits can mark inefficiency and conversely, a proper degree of efficiency can be accompanied by an absence of profit. The net profit figure simply reveals a satisfactory balance between the values received and value given (Trivedi, 2010).

Sometimes, the terms 'Profit' and 'Profitability' are used interchangeably. But in real sense, there is a difference between the two. Profit is an absolute term, whereas, the profitability is a relative concept. However, they are closely related and mutually interdependent, having distinct roles in business.

Profit refers to the total income earned by the enterprise during the specified period of time, while profitability refers to the operating efficiency of the enterprise. It is the ability of the enterprise to make profit on sales. Profitability is the ability of enterprise to get sufficient return on the capital and employees used in the business operation (Trivedi, 2010).

Nitisha (2016) defined profit as a reward received by an entrepreneur by combining all the factors of production to serve the need of individuals in the economy faced with uncertainties. In accountancy, profit implies excess of revenue over all paid-out costs. Profit in economics is termed as a pure profit or economic profit or just profit.

Accounting profit: Refers to the total earnings of an organization. It is a return that is calculated as a difference between revenue and costs, including both manufacturing and overhead expenses. The costs are generally explicit costs, which refer to cash payments made by the organization to outsiders for its goods and services. In other words, explicit costs can be defined as payments incurred by an organization in return for labor, material, plant, advertisements, and machinery.

The accounting profit is calculated as:

$$\text{Accounting Profit} = \text{TR} - (\text{W} + \text{R} + \text{I} + \text{M}) = \text{TR} - \text{Explicit Costs} \text{ -----}23$$

where;

TR = Total Revenue

W = Wages and Salaries

R = Rent

I = Interest

M = Cost of Materials

The accounting profit is used for determining the taxable income of farm firm or organization and assessing its financial stability. It is to be noted that the accounting

profit is also called gross profit. When depreciation and government taxes are deducted from the gross profit, we get the net profit.

Economic profit: Considers both explicit and implicit costs and imputed costs. Implicit that is the foregone which an entrepreneur can gain from the next best alternative use of resources. Thus, implicit costs are also known as opportunity cost. The examples of implicit costs are rents on own land, salary of proprietor, and interest on entrepreneur's own investment.

Let us understand the concept of economic profit. Suppose an individual A is undertaking his own business manager in an organization. In such a case, he sacrifices his salary as a manager because of his business. This loss of salary will be opportunity cost for him from his own business.

The economic profit is calculated as:

Economic profit- Total revenue-(Explicit costs + implicit costs)

Alternatively, economic profit can be defined as follows:

Pure profit = Accounting profit - (opportunity cost + unauthorized payments, such as bribes). Economic profit is not always positive; it can also be negative, which is called economic loss. Economic profit indicates that resources of a business are efficiently utilized, whereas economic loss indicates that business resources can be better employed elsewhere (Nitisha, 2016).

2.12 EMPIRICAL STUDIES ON THE RELATIONSHIP BETWEEN INPUT AND OUTPUT IN QUAIL AND CHICKEN PRODUCTION

Tijjani, H., Tijjani, B. A., Tijjani, A. N. and Sadiq (2012) reported the result of input / output relationship in poultry egg production indicating that the coefficients of the cost of hired labor flock size, feed, depreciating cost of equipment and other operating expenses were all positive and significant at 5, 1, and 10% respectively. High cost of feed, inadequate drug, lack of governmental support, poor management practices,

high mortality rate, high bird density and inadequate ventilation among others were the major problems associated with poultry egg production in Maiduguri and environs Borno state, Nigeria.

A study conducted by Ezeh, Anyiro and Chukwu (2012) measured the level of technical efficiency and its determinants in poultry broiler production in Umuahia Abia State, Nigeria. Multi-stage sampling technique was used to select 60 poultry broiler farmers from which the input-output data were collected using a structured questionnaire. The estimated stochastic (Cobb-Douglas) frontier production function showed that stock-size, feed intake and labour input were critical variables that affected farmers output at 1.0% risk level respectively. Drugs and medication and depreciation cost were not significant at given levels. The result showed that the estimated farm level technical efficiency ranged from 08% and 97% with a mean of 75%. The socio-economic determinants of technical efficiency were Extension contact, household size, age and educational level. Though the technical efficiency of the poultry broiler farmers is high but they are not fully technically efficient.

A research conducted on technical efficiency by Aboki, Jongur and Onu (2013) showed that the technical efficiency of family poultry production ranges between 0.29 and 0.84, with a mean of 0.63 which means the respondents are 63% efficient in the use of combination of their inputs. The study concluded that the output and technical efficiency of the family poultry production can be increased by the use of more feed, capital, medicine/vaccine and adoption of more innovations.

Jatto, Maikasuwa, Jabo and Gunu (2012) assessed the technical efficiency level of poultry egg producers in Ilorin, Kwara State using Data Envelopment Analysis. A stratified random sampling technique was adopted in selecting 150 poultry egg producers. The data for the study were collected with the use of well-structured

questionnaires from poultry farmers. The result showed the poultry egg farmers are relatively technically efficient in their use of resources, with a mean technical inefficiency of 26%. The mean input slack for numbers of birds, feeds and labour have slacks of 6.936, 91.021 and 0.334, respectively implying that inputs could be decreased by those units and still produce the same level of output. The study concluded that the poultry egg farmers are relatively technically efficient.

2.13 EMPIRICAL STUDIES ON THE RESOURCE-USE EFFICIENCY IN QUAIL AND CHICKEN PRODUCTION USING STOCHASTIC FRONTIER PRODUCTION ANALYSIS

Study was carried out to estimate the technical and economic efficiencies of poultry farmers in Imo State, Nigeria by Ohajianya, Mgbada, Onu, Henry-Ukoha, Benchendo and Godson-Ibeji (2013) the data was collected with semi-structured questionnaire from 140 randomly selected poultry farmers. A stochastic frontier production function was estimated by using the maximum likelihood estimation technique to obtain the technical and economic efficiencies of poultry farmers. The mean technical efficiency of poultry farmers was 75%, while their mean economic efficiency was 21%. The generalized likelihood test indicated that, the poultry farmers were not technically and economically efficient in resource use. There is 79% allowance to increase economic efficiency of poultry farmers by improvement in technical efficiency.

Nmadu, Ogidan and Omolehin (2014) reported the results of resource use efficiency, the study revealed that poultry egg farmers in Abuja, Nigeria had positive, decreasing returns to scale (0.508) in egg production which indicated that poultry egg production was in the rational stage of production (Stage 2). Poultry production was profitable in Abuja but the farmers were not fully efficient in the use of their resources.

2.14 EMPIRICAL STUDIES ON THE PROFITABILITY OF QUAIL AND CHICKEN PRODUCTION

The study on the economic analysis of poultry egg production was carried out in Maiduguri and environs of Borno State, Nigeria by Tijjani *et al.* (2012). Purposive sampling technique was employed for the study. Ten (10) wards out of the fifteen (15) wards in the area were selected. From each of the ten (10) wards, five (5) poultry egg producers were randomly selected, giving a total sample size of 50 respondents for the study. Structured questionnaire was administered to 50 poultry egg producers. Descriptive statistics, farm budgetary technique and multiple regression models were used as analytical technique. Analysis of the finding of costs and returns associated with poultry egg production showed that costs of feed and hired labour accounted for 80.65% and 5.25% of the total costs in poultry egg production respectively. The gross revenue, total cost and net farm income were ₦10, 500.00, ₦4,960.00 and ₦5, 540.00, respectively in the study area.

The main objective of the study conducted by Onyewuchi, Ofor and Okoli (2013) was to determine the profitability of quail bird and egg production (*Coturnix japonica*) in Imo State. A multi-stage sampling technique was adopted. First, two agricultural zones were purposively selected namely Owerri and Orlu Zones. Secondly, two communities were purposively selected from each of the zones making it a total of four communities. Thirdly, ten (10) livestock farmers were randomly selected from each of these communities making a total of 40 livestock farmers. Structured questionnaire and oral interview were used to gather data from the farmers. Data was analyzed using descriptive statistics and gross margin analysis. Results showed that 92.5% of the respondents are not aware of the existence of quail birds while 7.5% are aware. It was found out that the total cost of producing 45 quail birds for meat in 6 weeks was ₦12, 950 while the gross margin and net income were ₦21,

550 and ₦18, 550 respectively. It was also found that the total cost of producing about 267 crates of quail egg in 45 weeks was ₦83, 112.50 while the gross margin and net income were ₦657, 387.50 and ₦653, 887.50, respectively.

A Study was conducted in Bauchi Local Government Area, Bauchi state, Nigeria on the economics of quail bird production by Bakoji, Aliyu, Haruna, Jubril, Sani and Danwulle (2013). Random sampling technique was used to select 45 respondents used for the study. The data obtained was analyzed using descriptive statistics and gross margin. The result indicated that majority of the respondents (48.89%) fall within the age group of 31-40 of which 64.44% were male. Considerable number of the quail farmers had obtained tertiary education (73.33%). The result further revealed that (66.67%) had less than five years of rearing experience this signify that quail farming is entirely a new business in the area. However, majority of the respondents (66.67%) regarded quails' farming as a part time job. On average quail farmer invest ₦371,792 in the businesses with total revenue of ₦602,056.80. The result further stated that quail's business was found to be profitable with gross ratio, operation ratio, and return per naira invested to be 0.61, 0.60 and 1.61, respectively.

The profitability, break-even point, elasticity of production, and resource use efficiency of poultry egg production by poultry egg farmers was determined in Abuja, Nigeria by Nmadu *et al.* (2014). Primary data were collected from 62 farmers drawn from the area of study by a simple random sampling technique. Descriptive statistics, multiple regression, costs and returns analysis (budgeting), and break-even analysis were used to analyze the data. The costs and returns analysis indicated that an average farmer invested annually ₦3,504,352 in poultry egg production. The gross margin, net income, and gross return invested were ₦10,875,663.00, ₦ 9,798,772.00 and ₦1.72.00 respectively. These figures suggest that egg production in the study area

was profitable. The study also showed that the break-even point for an average poultry egg farmer in Abuja was 3,978 crates of eggs per annum and the margin of safety ratio was 89 percent.

2.15 EMPIRICAL STUDIES ON DISEASES

Gowthaman, Singh, Barathidasan, Ayanur, and Dham (2013) reported that Newcastle Disease (ND) is a highly infectious and contagious disease of domestic poultry and wild birds that could cause high morbidity and mortality. Newcastle Disease virus (NDV) infects wide variety of hosts including turkeys and quails. ND is highly endemic in Indian poultry industry. Frequent episodes of disease occur in domestic birds and it is capable to infect other bird species which kept alongside with poultry. There were no recorded reports on the occurrence of NDV in the commercial chickens farmed along with multi species, especially, turkeys and Japanese quails. A disease investigation was undertaken in a multi species poultry farm with the history of morbidity >30% and mortality (>20%) with unusual clinical manifestations of the central nervous system dysfunction in turkeys and Japanese quails kept along with poultry. Systematic necropsy examination was carried out in dead turkeys and Japanese quails and visceral organs were collected for virus isolation and histopathology. Cloacal swabs were also collected from apparently healthy chicken flocks. Virus isolation, Mean Death Time (MDT) assay and histopathology were carried out as per standard procedures. All infected turkeys and Japanese quails showed general weakness, loss of appetite, decrease in egg production and central nervous system (CNS) signs like torticollis, uncoordinated gait and backward movements, abnormal positioning of the head and neck such as opisthotonos. Postmortem examination and histopathology revealed prominent vascular and CNS alterations. ND virus was isolated from all the pooled samples from turkeys and

Japanese quails and 3 cloacal swabs from chickens. The MDT of the all isolates from turkeys and quails found to be 38–60 hours, whereas for chicken isolates the MDT exceeded 90 hours. This confirms the velogenic nature of the isolated ND virus in turkeys and Japanese quails (Gowthaman *et al.*, 2013).

Mohapatra *et al.* (2014), conducted a study on disease of quail called Egg Drop Syndrome-76 (EDS-76) which is a recognised disease of chickens and Japanese Quails, which is of high economic importance due to its drastic negative effects on egg production in laying birds. The aim of the study was to better understand the EDS-76 viral disease process in Japanese quails (*Coturnix coturnix japonica*), since very limited studies have been conducted in this species of birds. For this purpose, an experimental study was conducted with infection of EDS-76 virus in laying Japanese quails to reveal pathology, effect on egg production/quality and immune responses of this virus in these birds. By 7, 9 and 13-15-Days Post Infection (DPI), drop as well as aberrant egg production and lower mean egg quality were observed compared to control birds. Significant histopathological changes were observed in genitalia and spleen. Haemagglutination Inhibition (HI) and Enzyme Linked Immunosorbant Assay (ELISA) titres rose rapidly by 2nd week when it became maximum; thereafter declined and maintained at low levels up to 10-week post infection. The mean total protein values in infected quail gradually increased to $4.10 \pm 0.05/100$ mL without any change in mean albumen value at 12 DPI.

Teixeira, Cardoso, Lopes, Rocha-e-Silva, Albuquerque, Horn and Salles (2013), conducted a study to investigate the presence of Salmonella in common quails submitted to forced molting. They used 240 quails which were divided at 40 weeks of age into four groups: CG (control, quails not submitted to molting); FM (fasting method); WM (fed wheat midds ad libitum); and ZM (zinc oxide method). From each

group, 10 cloacal swabs, 10 fecal samples, and 20 egg samples were collected before molting (two weeks) and after molting (two weeks). The microbiological procedures for *Salmonella* spp. identification were performed in four steps. The agglutination test, using somatic and flagellar antigens, was used to confirm *Salmonella*-suspected colonies. According to the methodology applied, none of the samples was positive for *Salmonella* spp. The results showed that 20.0% of the egg samples from birds submitted to forced molting were contaminated with enterobacteria. It was concluded that, under the conditions of the present experiment, the stress caused by forced molting did not induce infection by *Salmonella* spp. or increased Enterobacteriaceae contamination levels in the eggs.

2.16 EMPIRICAL STUDIES ON QUAIL AND CHICKEN EGG MARKETING

Ekunwe and Alufohai (2009) examined the profitability of egg marketing as well as the market structure and marketing margin of poultry egg in Benin City, Edo state, Nigeria. Six markets (Uselu, Oliha, Ogida, Oba, Osa and New Benin markets) in Benin City were purposively selected for the study, after which ten egg sellers were randomly selected from each of the six markets giving a sample size of 60. Primary data were obtained through the use of a well-structured questionnaire and personal interview. The data obtained were analyzed using descriptive statistics, Gini coefficient and Gross margin. The results of the analysis showed that 96.7% of the respondents were females. The mean age of the respondents was 45 years while the household size was 6 persons. A Gini coefficient of 0.81296 obtained in the study indicates a high level of inequality in income distribution among the respondents. The profitability analysis showed a gross margin per seller of ₦104.61, a net return per seller of ₦93.74 and a marketing margin of ₦0.53 was obtained in the study area.

A study was carried out on the Economic analysis of Poultry egg marketing in Kuje Area Council Abuja, Nigeria by Mohammed, Mohammed, Ayanlere and Afolabi (2013). The data were obtained using Structured Questionnaires administered to 40 egg marketers. Descriptive statistics, marketing margin analysis and gross-Margin were used to analyze the data. The result showed that 95% of the marketers were between 21-50years, 95.5% were married, and male70% dominated egg marketing. All the marketers 100%had primary education, 87.5% had over five years of experience in egg marketing. Egg marketing in the study area was profitable with about ₦37,500 per month and had a marketing margin of 20% and a return to investment of ₦0.25 on every naira.

Akarue and Isene (2014) evaluated egg marketing in Effurun and its environs in Uvwie and Warri-South Local Government Area of Delta State. Research specifically identified the socio-economic characteristics of the respondents, examined the market structure, determined the profitability of egg marketing and determined the influence of some socio-economic characteristics on the sales revenue of the respondents. Primary data used in the study were collected using structured questionnaire to the 70 respondents, through a multi stage sampling technique. Data collected were analyzed using descriptive statistics, Gini-coefficient, Gross margin analysis and Production function. The result showed that only 10% of the respondents were single while the remaining 90% were married. A literacy level of 51% was obtained among the marketers. Analysis also revealed that the profitability level of the marketers showed ₦52,593.71 per month. The Gini Coefficient of 0.865.03 obtained in this study indicated a high level of inequality in income among the respondents.

2.17 EMPIRICAL STUDIES ON MARKET STRUCTURE AND CONDUCT

Yusufu and Ayanwale (2011) assessed the structure, conduct, and profitability associated with the broiler processing market in Southwestern Nigeria. The Structure-Conduct-and-Performance (SCP) model was used to analyze the primary data collected on the processors and marketers of broiler meat, in a panel of three years spanning 2004 - 2006. The market structure was estimated using the market Concentration Ratios, Herfindahl Index and the Gini Coefficient; the marketing channel was used to assess the market conduct while rate of returns on investment was used to assess the profitability of the market. The results of the market structural parameters showed that the concentration ratios (CR2) for the market were 73.9%, 72.7% and 75.9% in years 2004, 2005 and 2006 respectively. The CR4 values were 94.4%, 94.7% and 93.3%, while the CR8 were 98.5%, 98.7% and 98.2%, respectively. The values of the Herfindahl index (HI) were 0.351, 0.552 and 0.577, respectively, while the Gini Coefficient was 0.90. These parameters showed that there was a high degree of concentration in the industry implying a monopolist market structure. The conduct of the market revealed vertical integration, a zero - and a one – level marketing channel. The cost of processing was between ₦358 and ₦396 per kg for the large-scale processors and between ₦403 and ₦432 per kg for the small-scale processors. The rate of returns on investment showed that the large-scale processors had higher rate of returns of between 4.3 and 6.2% on their investments compared to less than 3% for small scale processors.

Tiku, Olukosi, Omelehin and Oniah (2012) examined the structure, conduct and performance of palm oil marketing in Cross River State, Nigeria. Multi-stage sampling techniques was used in the selection of 6 local Government Areas, 18 Villages, 180 processes, 90 commissioned agents, 90 retailers and 30merchants for

the study. The descriptive statistics, the Gini co-efficient combined with the Lorenz curve was used to determine the degree of market concentration among the participants; the marketing margin analysis was employed to measure the performance of palm oil marketing in Cross River State. The result reveals that the Gini Value for processors, commissioned agents, Merchants and retailers was 59, 54, 65 and 32%, respectively. The overall performance of the market was 41.43%, the processors received 37.17% of the market share, merchants 29%, and retailers 26% and commissioned agent 7.8%. Generally, the market was observed to be a pure market competitive.

Olagunju, Babatunde and Salimonu (2012) analyzed the gari industry through a Structure-Conduct-Performance (SCP) framework utilizing cross-sectional data for the year 2009 in Southwestern Nigeria. A multi-stage sampling technique was used to select 260 gari marketers in the study area and structured questionnaire administered to them. Descriptive statistics, gross margin, Gini coefficient and production function analysis techniques were used. The profitability analysis showed that an average marketer incurred an average total variable cost of ₦7, 640.30 per week but earned average revenue of ₦12, 452.35 per week indicating ₦4, 812.05 as gross margin. A Gini coefficient of 0.4256 obtained indicated a high level of concentration in the gari market.

Abdulrazak, Zainalabidin, Mad Nasir and Ismail (2013) considered the structure conduct performance (SCP) model to assess degree of competition in the supply chain of the Malaysian poultry market. Malaysian Poultry industry Firm's financial data for period 2005-2011 obtained from Company Commission of Malaysia (CCM) was used for analysis. Results of the analysis could not prove any allegation of anti-competitive behavior and or exercise of market power by the integrators along the supply chain.

However, the Farm level market was moderately concentrated over the study period as indicated by the CR4 61.9%. The overall performance of the industry based on results of the profitability ratio suggests the industry is doing quite well over the study period.

CHAPTER THREE

3.0 METHODOLOGY

3.1 THE STUDY AREA

The study was conducted in Kano State which is situated within the latitude $10^{\circ}33'N$ - $12^{\circ}37'N$ and longitude $7^{\circ} 34'E$ - $9^{\circ} 29'E$, covering a land area of $20,760\text{km}^2$. The mean daily maximum and minimum temperatures are 44°C and 38°C in dry season, respectively and 33°c and 16°c during harmattan. Rainfall is concentrated from June to September. The average annual rainfall is 870.20 millimeters. According to National Population Commission (NPC) (NPC, 2006), the state has a population of 9,383,682 inhabitants, with projected annual growth rate put at 3.3%, the projected population shall be 13,409,282 in 2019; it has 44 Local Government Areas. Agricultural land is put at 1,754,200ha, while forest and grazing land covers 75,000ha (KNSG, 2004).

The state has a number of markets within the Metropolitan Local Government Areas (LGAs) notably, Sabon Gari, Kurmi, Tarauni, Sheka, Kofar wambai, Rimi, Gama and Sharada. Markets in these market one can have both quail and chicken eggs. There are also local retail shops where you can have the commodity spread in the metropolitan area and Shopping Malls like Shop Rite, Sahad Stores, Country Mall and Jifatu Store Etc. The population of the state and perception by many on the health benefits of the quail products and the deficiency in animal protein consumption provides the opportunity for exploiting the full potentials of the quail and chicken egg production and marketing in the study area. Figure 1; depicts the location of the study area

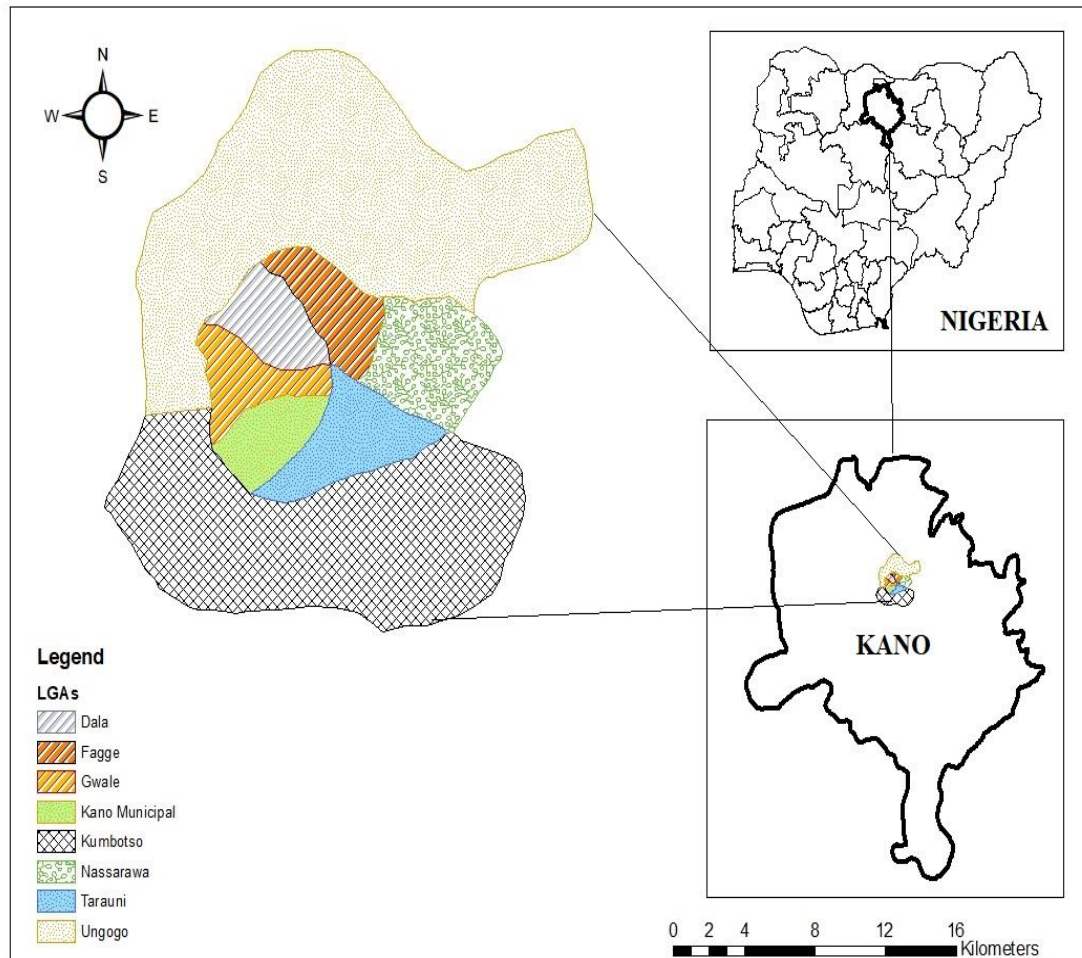


Figure 3.1: Map showing Kano Metropolis, Nigeria.

3.2 SAMPLING TECHNIQUES

Purposive sampling was employed using referral techniques to identified the total number of 78 quail producers, 43 were small-scale operators while 35 were medium-scale operators and 68 quail egg marketers were identified for the study, 36 of them were retailers while 32 were wholesalers. The entire identified quail producers and marketers were taken for the study because of being well defined and small. Equal number of chicken producers and marketers were selected using random sampling technique from sampling frame obtained from list of poultry producers' association membership. 78 chicken egg producers were selected, 43 of them were small-scale operators while 35 were medium-scale operators and 68 chicken egg marketers were

selected, 36 of which were retailers while 32 were wholesalers. Sample size of the chicken egg producers is presented in Table 1

Table 1: Sample Size of the Chicken Egg Producers

S/N	Local Government Area	Small-scale	Medium-scale
1	Municipal	5	3
2	Dala	5	4
3	Gwale	5	5
4	Tarauni	6	4
5	Nasarawa	5	4
6	Fagge	5	5
7	Ungogo	6	4
8	Kumbotso	6	6
	Total	43	35

Categorization of producers and marketers

Classification of poultry chicken producers by Ajibefun and Daramola (1999) was adopted in the research as:

<500 Birds = Small scale producers,

501 – 1000 Birds = Medium scale producers.

Both the small and medium-scale operators were sampled. For the marketers; those with volume of egg sales below 20 crates per week were categorized as retailers and those with 21 and above sales of crates of egg per week were categorized as wholesalers.

3.3 METHOD OF DATA COLLECTION

Primary data were collected which include information on the Producers, Marketers, cost of inputs, prices of products, quantity of inputs utilized, flock size, available markets and other relevant information. The collection was done by the researcher

with the assistance of trained enumerators. Different questionnaires were used for producers and marketers.

3.4 TOOLS OF ANALYSIS

3.4.1 Descriptive Statistics

Descriptive statistics was used to achieve objective number i which is describing the socio-economic characteristics of the Producers, Marketers of quail and chicken eggs and parts of objectives iv and v. This involved the use of percentages and frequency distributions and means.

3.4.2 Frontier Production Function Analysis for Quail and Chicken Egg Production

Frontier production function analysis was used to determine the efficiency in production as applied by Ezech *et al.* (2012), Ali and Samad (2013) and Adedeji *et al.* (2013) to achieve objective ii. The stochastic frontier production function is defined by; $Y_i = f(x_i; \beta) \exp(V_i - U_i), i = 1, 2, \dots, N$, -----25

where;

Y_i represents the possible production level for the i^{th} sample firm i.e. (the output);

$f(x_i; \beta)$ is a suitable function (e.g., Cobb-Douglas or TRANSLOG) of the vector, x_i , of inputs for the i^{th} firm and a vector, β , of unknown parameters i.e.(parameter coefficients to be determined);

V_i is a random error having zero mean, which is associated with random factors (e.g., measurement errors in production, weather, industrial action, etc.) not under the control of the firm.

U_i is a non-negative random variable associated with firm-specific factors which contribute to the i^{th} firm not attaining maximum efficiency of production; and

N represents the number of firms involved in across-sectional survey of the industry (Battese, 1991).

The technical efficiency of firm i in the context of the stochastic frontier production function

$$TE_i = \exp(-U_i), \text{-----26}$$

i.e., $TE_i = Y_i/Y_i^*$

$$= f(x_i; \beta) \exp(V_i - U_i) / f(x_i; \beta) \exp(V_i)$$

= $\exp(-U_i)$. where;

TE_i is the technical efficiency

Y_i is the observed output

Y_i^* is the frontier output

The Cobb-Douglass functional form for frontier production estimated was described as in Asogwa, Ihemeje and Ezihe (2011) by:

$$\text{Log } Y_i = \beta_0 + \beta_1 \log(x_{1i}) + \beta_2 \log(x_{2i}) + \beta_3 \log(x_{3i}) + \beta_4 \log(x_{4i}) + (V_i - U_i) \text{-----27}$$

Where; Log represents the logarithm base 10; the subscript i represents the i^{th} sample quail and chicken farmer.

Technical inefficiency effect model as applied in kyj and Oppen (1999) is described by

$$U_{it} = \delta_0 + \delta_i Z_{it} \text{-----28}$$

where;

Z_{it} is a (1 x M) vector of explanatory variables associated with the technical inefficiency effects in the t^{th} time period

δ is an (M x 1) vector of unknown parameters estimated.

Technical efficiency for quail egg production

The empirical stochastic frontier model for quail egg farmers is given by:

$$\text{Log } Y_{it} = \beta_0 + \beta_1 \log(x_{1i}) + \beta_2 \log(x_{2i}) + \beta_3 \log(x_{3i}) + \beta_4 \log(x_{4i}) + (V_i - U_i) \text{-----29}$$

where;

Y represents the quantity of quail egg produced (Crates).

X₁ represents the stock size of quail layers (Number).

X₂ represents the quantity of feed (Kg)

X₃ represents the quantity of labour (Man days).

X₄ represents the quantity of water (Litres).

$\beta_j = 0, 1, \dots, 4$ are parameters to be estimated

V_i's are assumed to be independent and identically distributed N (0, σ_v^2) random variables

U_i's are assumed to be independent and identically distributed non-negative truncations of the N (μ, σ^2) distribution.

In order to determine the contributing factors to the observable technical efficiency, the following model was adopted as in Ezech *et al.* (2012) and Ali and Samad (2013) who formulated and estimated jointly with the stochastic frontier model in a single stage maximum likelihood estimation procedure using FRONTIER 4.1 software.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \text{-----} 30$$

where;

U_i is the Technical Inefficiency of the ith farmer,

Z₁ is credit access

Z₂ is the farmer's age (years)

Z₃ is farmer's level of education (years)

Z₄ is farmer's farming experience (years)

Z₅ is sex of farmers and

Z₆ is membership of association

While $\delta_0, \delta_1, \dots, \delta_6$ are parameters to be estimated.

Technical efficiency for chicken eggs production

The empirical stochastic frontier model for chicken egg farmers is given by:

$$\text{Log } Y_{it} = \beta_0 + \beta_1 \log(x_{1ij}) + \beta_2 \log(x_{2ij}) + \beta_3 \log(x_{3ij}) + \beta_4 \log(x_{4ij}) + (V_i - U_i) \text{-----} 31$$

where;

Y represents the quantity of Chicken eggs produced (Crates).

X₁ represents the stock size of Chicken layers (Number)

X₂ represents the quantity of feed (Kg).

X₃ represents the quantity of labour (Man days).

X₄ represents the quantity of water (Litres).

$\beta_{ij} = 0, 1, \dots$, are parameters to be estimated

V_i 's are assumed to be independent and identically distributed $N(0, \sigma_v^2)$ random variables. U_i 's are assumed to be independent and identically distributed non-negative truncations of the $N(\mu, \sigma^2)$ distribution.

In order to determine the contributing factors to the observable technical efficiency, the following model was adopted as in Ezech *et al.* (2012) and Ali and Samad (2013) who formulated and estimated jointly with the stochastic frontier model in a single stage maximum likelihood estimation procedure using FRONTIER 4.1 software.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \text{-----} 32$$

Where

U_i is the Technical Inefficiency of the i^{th} farmer,

Z_1 is credit access

Z_2 is the farmer's age (years)

Z_3 is farmer's level of education (years)

Z_4 is farmer's farming experience (years)

Z_5 is sex of farmers and

Z₆ is membership of association

While $\delta_0, \delta_1, \dots, \delta_6$ are parameters to be estimated.

Allocative (cost) efficiency for quail eggs production

The empirical stochastic frontier for allocative efficiency (cost function) of quail farmers is given by:

$$\text{Log } C_1 = \beta_0 + \beta_1 \log P_1 + \beta_2 \log P_2 + \beta_3 \log P_3 + \beta_4 \log P_4 + (V_i + U_i) \text{-----} 33$$

where;

C₁ = Total production cost (₦)

P₁ = Cost of layer quail (₦)

P₂ = Cost of feed (₦)

P₃ = Cost of labour (₦)

P₄ = Cost of water (₦)

The model for allocative inefficiency is given as:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \text{-----} 34$$

U_i is the allocative inefficiency of the ith farmer,

Z₁ is credit access

Z₂ is the farmer's age (years)

Z₃ is farmer's level of education (years)

Z₄ is farmer's farming experience (years)

Z₅ is sex of farmers and

Z₆ is membership of association

While $\delta_0, \delta_1, \dots, \delta_6$ are parameters to be estimated.

Allocative efficiency for chicken eggs production

The empirical stochastic frontier for allocative efficiency (cost function) of chicken egg farmers is given by:

$$\text{Log } C_1 = \beta_0 + \beta_1 \log P_1 + \beta_2 \log P_2 + \beta_3 \log P_3 + \beta_4 \log P_4 + (V_i + U_i) \text{-----}35$$

where;

C_1 = Total production cost (₦)

P_1 = Cost of layer chicken (₦)

P_2 = Cost of feed (₦)

P_3 = Cost of labour (₦)

P_4 = Cost of water (₦)

The model for allocative inefficiency is given as:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \text{-----}36$$

U_i is the allocative inefficiency of the i^{th} farmer,

Z_1 is credit access

Z_2 is the farmer's age (years)

Z_3 is farmer's level of education (years)

Z_4 is farmer's farming experience (years)

Z_5 is sex of farmers and

Z_6 is membership of association

While $\delta_0, \delta_1, \dots, \delta_6$ are parameters estimated.

In the context of frontier production function, the technical efficiency of a farm is the ratio of the observed output to the corresponding frontier output conditional on the level of input used by the farm. Thus, technical efficiency of farm i is given

$$TE_i = \exp (-U_i), \text{-----}37$$

i.e., $TE_i = Y_i/Y_i^*$

TE_i = Technical efficiency of farmer i , Y_i = observed output and Y_i^* = frontier output.

The technical efficiency of a farm ranges between values 0 to 1. Maximum efficiency

in production has value of 1. Lower value represents less than maximum efficiency in production (Ali & Samad, 2013).

3.4.3 Farm Budgeting

Farm budgeting method was used to achieve objective three that is the profitability of quail and chicken egg enterprise. The Net Farm Income (NFI) is the difference between the Gross Revenue (GR) and the Total Cost (TC) of Production (Bakoji *et al.*, 2013). The cost of production consists of total cost incurred during the production period. It includes variable and fixed components. The model is specified as:

$$NFI = GR - TVC - TFC \text{ -----}48$$

where;

NFI = Net Farm Income (₦) per quail per production cycle (58weeks) and per chicken per production cycle (72 weeks).

GR = Gross Revenue (₦) per quail per production cycle (58weeks) and per chicken per production cycle (72 weeks).

TVC = Total Variable cost (₦) in quail production cycle (58weeks), and in chicken production cycle (72 weeks).

TFC (Total Fixed Cost) (₦) per quail per production cycle (58weeks) and per chicken per production cycle (72 weeks).

TC (Total Cost of Production) (₦) per quail per production cycle (58weeks) and per chicken per production cycle (72 weeks).

Gross revenue-includes sales from bird, eggs and litter etc.

Total variable costs are cost of birds, feeds, wages on labor and veterinary service.

Total fixed costs are cost of building, interest on loan and cost of equipment.

3.4.4 Financial Ratios

Financial ratios used include: Gross Ratio (GR), Operating Ratio (OR) and Rate of Return Ratio (ROR). The ratios are expressed by Olukosi and Erhabor (1988) as

GR = Total cost (TC)/Total Revenue (TR), this gives measure of the overall success of a farm firm, showing how successful quail and chicken egg production business is.

OR = Total variable Cost (TVC)/Total Revenue (TR), this gives proportion of gross income that goes to pay for the variable inputs usage.

ROR = Net Return (NR)/Total Cost (TC), this is a gain or loss on an investment over a specified period of time, expresses as percentage of investment's costs, that is gain or loss in the quail or chicken egg production business.

3.4.5 Market Structure and Conduct

Market structure

Market structure was determined via calculating Gini coefficient as:

$$G = 1 - \sum x y \text{ -----} 38$$

where; G = Gini coefficient.

x = Percentage of market participants. Representing the number of quail and chicken egg marketers operating within the markets;

y = Cumulative purchase of products. Representing the value of the total crates of quail or chicken egg sold in Naira.

Gini coefficient is equal to zero when there is perfect equality in the size and distribution of buyers and sellers and G = 1 when there is perfect monopoly in the market. Generally, Gini coefficient value range from zero to one and expresses the extent to which market is concentrated as applied by Ike and Chukwuji (2005); Ekunwe and Alufohai (2009); Tiku, Olukosi, Omelehin and Oniah (2012).

Market conduct

The market conduct was determined as used by Bosena, Bekabil, Berhanu and Dirk (2011) and Ruttoh, Bell and Nyaro (2018). Qualitative data were collected from producers and marketers which expressed exploitative condition which used to describe their conduct. Factors affecting price determination of products as identified by Kalpana (2017) were also used, the factors are: product cost, utility/demand, extent of competition in the market, legal regulation, pricing objectives and marketing methods.

3.4.6 Marketing Margin

Marketing margin was used to evaluate the marketing of both quail and chicken egg. Marketing margin is the difference in prices paid at different stages of marketing at different times. The total marketing margin was calculated based on the following formula as used by Mabood, Pasban and Moghaddasi (2014):

$$Mm = Mr + Mw \text{ -----}41$$

Mm is the total marketing margin, Mr is the retail margin and Mw is the wholesale margins. Wholesale margin, is the difference between the wholesale price and received price by the quail or chicken egg producers and is calculated from the following formula:

$$Mw = Pw - Pf \text{ -----}42$$

Mw is the wholesale margins, Pw is the wholesale price and Pf is the price received by quail or chicken egg producers. Also, retail margin which is difference between wholesale and retail prices can be calculated from the following equation

$$Mr = Pr - Pw \text{ -----}43$$

Mr is the retail margin, Pr is the retail price and Pw is the wholesale price.

Retail price is amount paid for a crate of egg by the consumer of quail or chicken egg to the egg retailer

Generally, the total cost of the activities and performed services on the product (quail or chicken eggs) in the gap between production and consumption, which is as percentage of the price of the offered product to the consumer, is called marketing cost index (Mabood *et al.*, 2014). The index was calculated as in Kohansal and Akbari (2013) from the following equation:

$$R = (Pr - Pf/Pr) \times 100 \text{ -----44}$$

where; Pr is the retail price of a crate of quail or chicken egg, Pf producer price of quail or chicken egg and R is the cost ratio of marketing. This ratio represents the share of marketing costs in the final price of the crate of quail or chicken egg. Also, in the study in order to understand the issues in quail marketing in the study area, share of producer, wholesaler and retailer of the final price of the crates of quail and chicken egg was calculated using the following formula:

$$\text{share of quail or chicken egg producer} = (Pf/Pr) \times 100 \text{ -----45}$$

$$\text{share of wholesaler of quail or chicken egg} = \{(Pw-Pf)/Pr\} \times 100 \text{-----46}$$

$$\text{share of retailer of quail or chicken egg} = \{(Pr-Pw)/Pr\} \times 100 \text{-----47}$$

In formulas above Pf, Pr and Pw respectively are, farm gate prices, retail and wholesale price (Mabood *et al.*, 2014; Kohansal and Akbari 2013).

3.5 DESCRIPTION OF VARIABLES AND THEIR *APRIORI* EXPECTATIONS

Age: Period of human life, measured by years from birth, usually marked by a degree of mental or physical development and involving legal responsibility and capacity. It is the number of years an egg producer or marketer lived. Age should be positive sign.

Experience: Is the familiarity with a skill or field of knowledge acquired over years of actual practice which resulted in mastery. Therefore, years of experience are length

of time producers or marketers of quail and chicken eggs were involved in the business, measured in years with expected positive influence.

Sex: Refers to the two main categories male and female into which humans are divided on the basis of their reproduction functions. According to Newman (2018), in general terms, "sex" refers to the biological differences between males and females, such as the genitalia and genetic differences. Here it is a segregation of producer or marketer into male or female. It should have positive sign.

Household size: Is essentially the number of persons for whom you are financially responsible; in this case it is the number of persons quail, chicken egg producer or marketer is financially responsible to. It is expected to have a negative influence on efficiency.

Marital status: Is the personal status of each individual in relation to the marriage laws or customs of a country. Marital status is the personal status of each individual in relation to the marriage laws or customs of a country. The categories of marital status are: (1) single, (2) married, (3) widowed and not remarried, (4) divorced and not remarried and (5) married but separated (UN, 2018). It is the classification of quail or chicken egg producers or marketers into his/her marital status.

Education level: Years spent in pursuing formal education by quail or chicken egg producer or marketer. Measured in years and it should have positive influence.

Income level: Amount of money earned in Naira by quail or chicken egg producer or marketer in a year. Higher income level would result in re-investment into the business with positive influence.

Stock Size: This refers to the number of birds kept by either quail or chicken egg producer. This determines the quantity of eggs that would be produced by a producer. It is measured in number and should have positive sign.

Feed: Quantity of feed used in quail and chicken egg production per cycle. Measured in kilogram and expected to have positive influence on production output.

Labour: Amount of labour used in quail and chicken egg production. It is measured in Man-day.

Volume of sales: Is the quantity of quail or chicken eggs sold per week by the marketers in crates.

3.6 VALIDITY AND RELIABILITY OF INSTRUMENT

3.6.1 Validity of the Instrument

Validity refers to the degree to which an instrument accurately measures what it intends to measure. Yue (2016) reported three common types of validity for researchers are:

- 1 **Content validity** indicates the extent to which items adequately measure or represent the content of the property or trait that the researcher wishes to measure. Subject matter expert review is often a good first step in instrument development to assess content validity, in relation to the area or field you are studying.
- 2 **Construct validity** indicates the extent to which a measurement method accurately represents a construct (e.g., a latent variable or phenomena that can't be measured directly, such as a person's attitude or belief) and produces an observation, distinct from that which is produced by a measure of another construct. Common methods to assess construct validity include, but are not limited to, *factor analysis, correlation tests, and item response theory models*.
- 3 **Criterion-related validity** indicates the extent to which the instrument's scores correlate with an external criterion (i.e., usually another measurement from a different instrument) either at present (*concurrent validity*) or in the

future (*predictive validity*). A common measurement of this type of validity is the correlation coefficient between two measures (Yue, 2016).

3.6.2 Reliability of the Instrument

Reliability refers to the degree to which an instrument yields consistent results. Common measures of reliability include internal consistency, test-retest, and inter-rater reliabilities.

1. **Internal consistency reliability** looks at the consistency of the score of individual items on an instrument, with the scores of a set of items, or subscale, which typically consists of several items to measure a single construct. *Cronbach's alpha* is one of the most common methods for checking internal consistency reliability. Group variability, score reliability, number of items, sample sizes, and difficulty level of the instrument also can impact the Cronbach's alpha value.
2. **Test-retest measures** the correlation between scores from one administration of an instrument to another, usually within an interval of 2 to 3 weeks. Unlike pre-post tests, no treatment occurs between the first and second administrations of the instrument, in order to test-retest reliability. A similar type of reliability called *alternate forms*, involves using slightly different forms or versions of an instrument to see if different versions yield consistent results.
3. **Inter-rater reliability checks** the degree of agreement among raters (i.e., those completing items on an instrument). Common situations where more than one rater is involved may occur when more than one person conducts classroom observations, uses an observation protocol or scores an open-ended test, using a rubric or other standard protocol. Kappa statistics, correlation

coefficients, and intra-class correlation (ICC) coefficient are some of the commonly reported measures of inter-rater reliability.

Content validity and test-retest were applied because it involves contributions of professionals in the subject area. According to Taherdoost (2016), steps are:

1. An exhaustive literature reviews to extract the related items.
2. A content validity survey is generated (each item is assessed using three point scale (not necessary, useful but not essential and essential).
3. The survey should send to the experts in the same field of the research.
4. The content validity ratio (CVR) is then calculated for each item by employing Lawshe’s method.
5. Items that are not significant at the critical level are eliminated.

Lawshe’s Formula is given as: $CVR = (n_e - N/2) / (N/2)$, where; CVR is the content validity ratio, n_e is the number of panel members indicating “essential,” and N is the total number of panel members. The final evaluation to retain the item based on the CVR is depends on the number of panels. Taherdoost (2016) reported the minimum value of CVR for the evaluated item to be retained at $P = .05$:

No. of Panelists	Minimum Value
5	.99
6	.99
7	.99
8	.75
9	.78
10	.62
11	.59
12	.56
13	.54
14	.51
15	.49
20	.42
25	.37
30	.33
35	.31
40	.29

According to Surbhi (2017), to assess reliability, approaches used are test-retest, internal consistency methods, and alternative forms. There are two key aspects:

Stability: Degree of stability can be checked by making a comparison of the results of repeated measurement.

Equivalence: Equivalence can be gauged when two researchers compare the observations of the same events.

Systematic errors do not affect reliability, but random errors lead to inconsistency of the results, thus lower reliability. When the research instrument conforms to reliability, then one can be sure that the temporary and situational factors are not interfering. Reliability can be improved by way of:

- 1 Standardizing the conditions under which the measurement occurs, i.e. source through which variation takes place should be removed or minimized.
- 2 Designing the directions carefully for measurement by employing such individuals who have got enough experience and are motivated too, for carrying out research and also by increasing the number of samples being tested.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 SOCIO-ECONOMIC CHARACTERISTICS OF QUAIL AND CHICKEN EGG PRODUCERS AND MARKETERS

Socio-economic characteristics can give insight into respondents' behavior which will enable description of their productivity. In this study the socio-economic variables include age, house hold size, years of experience and stock size, gender, marital status, and level of education as shown in Tables 2 to 3. The producers were segregated into small and medium scale operators while the marketers were grouped into retailers and wholesalers.

4.1.1 Age Structure of the Producers

On the average there seems to be no clear difference in age among quail and chicken egg producers. Although the average age (41 years) of small-scale quail producers was found to be higher than that of chicken producers (32 years); a comparison between medium-scale producers shows 42 and 40 years for quail and chicken producers respectively. It can be seen that age range of 40-49 has 47% in quail and 20-29 has 53% in chicken egg production in small-scale production, this has to do with the fact that youth dominates chicken production as a results of poverty alleviation programmes that involves training the youth in chicken production. Age is known to have correlation with years of experience in agricultural enterprise management. Generally chicken producers have higher years of experience compared to quail producers; this is not surprising considering that, improved chicken production was adopted decades before quail production was known. Despite these, the difference between years of experience in quail and chicken production was not up to a decade, probably because chicken egg production was having investors joining

the business every now and then, this was seen in many skills acquisition training programs aimed at reducing poverty in the state were in chicken production. The age determines the experience and authority over resources.

The mean ages of both egg producers as shown in Table 2, indicated that the producers were adults in their economically active years with full responsibilities as the heads of their families. This result complements the findings of Maikasuwa and Jabo (2011), who reported 30 years as average of poultry farmers' age. Adeniyi and Ogutunji (2011) reported a majority of poultry keepers were adults in their economically active working age of 61 to 65 years. Ezeh *et al.* (2012) reported the mean age value of 38 years. Olayinka *et al.* (2014) reported a mean age of quail producers of 44 years in which farmers were in their economically active years. Nmadu *et al.* (2014) reported an age range of 41 to 50 years indicating the farmers were in their productive years. Memon, Noonari, Asif...Jamiro (2015) reported age as very important variable which influences the efficient allocation of resources and further said it shows the ability to do work, efficiency, willingness to make progress and attitude towards various social and economic aspects of life. Yusuf and Malomo (2007) reported an average of 44 years for chicken egg farmers. Ahmed *et al.* (2014) reported man age of chicken egg producers as 39 years. Odimegwe, Babatunde, Festus and Sunday (2015) reported average of poultry farmers as 43 years. Hassan *et al.* (2016) reported a majority of poultry farmers to be in their 40's and Folorinso, Abia, Okoroji, Dawang and Binyyo (2016), reported a mean age of 36years.

Table 2: Socio-economic Characteristics of Quail and Chicken Egg Producers

Variable	Small-Scale				Medium-Scale			
	Quail		Chicken		Quail		Chicken	
Age	Freq	%	Freq	%	Freq	%	Freq	%
20 – 29	8	18.	23	53	5	14	10	28.6
30 – 39	20	47	12	28	12	34	9	26
40 – 49	10	23	6	14	12	34	8	23
50 – 59	5	12	2	5	5	14	8	23
60 – 69	0	0	0	0	1	3	0	0
Mean	41		32		42		40	
Years of Experience								
1 – 4	25	58	20	47	14	40	5	14
5 – 8	18	42	11	26	21	60	14	40
9 – 12	0	0	3	7	0	0	5	14
13 – 16	0	0	7	16	0	0	5	14
17 – 20	0	0	2	5	0	0	6	17
Mean	4		7		5		11	
Household size								
1 – 3	4	9	36	84	4	11	17	49
4 – 6	18	42	6	14	11	31	13	37
7 – 9	9	21	1	2	8	23	5	14
10 – 12	4	9	0	0	7	20	0	0
13 – 15	8	19	0	0	5	14	0	0
Mean	8		2		8		4	
Stock size								
101 - 200	40	93	7	16	0	0	0	0
201 – 300	3	7	16	37	18	51	0	0
301 – 400	0	0	7	16	9	26	0	0
401 – 500	0	0	13	30	2	6	0	0
501 – 1000	0	0	0	0	6	17	35	100
Mean	144		341		637		792	
Sex								
Male	43	100	29	67	35	100	29	83
Female	0	0	14	33	0	0	6	17
Marital status								
Single	0	0	14	33	1	3	7	20
Married	43	100	29	67	34	97	28	80
Education level								
Informal Islamic	4	9.3	0	0	2	5.7	0	0
Primary	2	4.7	4	9.3	1	2.9	2	6
Secondary	6	13.9	17	39.5	9	25.7	11	31
Tertiary	31	72	22	51.2	23	65.7	22	63
Total	43	100	43	100	35	100	35	100

4.1.2 Experience of the Producers

Years of experience which has correlation with age of farmers has resulted in superior understanding or mastery. Therefore, years of experience are length of time producers

of quail and chicken eggs were involved in the business in Kano metropolis. As shown in Table 2, there is exists a clear difference between the average years of experience among the egg producers, small-scale quail (4 years) and chicken (7 years); medium-scale quail (5 years) and chicken (11years), these differences were due to long term existence of the chicken egg enterprise in the study area before the quail enterprise which just started in 2008 that's a decade ago. Similar findings were that of Hassan *et al.* (2016) reported a mean value of 10 years' experience and further said it was a period enough to make producers to adopt new technology in their production as experience is said to be the best teacher. Ahmed, Mohammed and Zamani (2014) reported a mean value of years of experience to be 14. Odimegwe *et al.* (2015) reported an average year of experience of 9 with majority of the farmers having 5 years. Maikasuwa and Jabo (2011) reported a majority of poultry farmers having one to five years of experience. But Memon *et al.* (2015) reported farmers of 30 years of experience as the majority among egg producers.

4.1.3 Household Size of the Producers

Household size is essentially the number of persons for whom you are financially responsible (UN, 2017); it is the number of persons quail or chicken egg producer is financially responsible to. The mean Household size of both small-scale and medium scale quail egg producers were eight (8) which were identified as total number of people living together under the care of one quail producer. But in the case of chicken egg producers the house hold size was two (2) and four (4) for small-scale and medium-scale respectively. It was clearly observed that the chicken egg producers had smaller house hold sizes which might be due to dominance of youth in chicken egg production business, it is pertinent to note that most of the skills acquisition programmes were aimed for the youth in which chicken production is one and it was characterized by less

labour requirement. The chicken enterprise has the ability to offer sustainable means of income generation. These findings are similar to that of Ali and Samad (2013) were they reported an average household size of 5. Memon *et al.* (2015) described family as social group in society typically consisting of parents and their children. Ahmed *et al.* (2014) reported a mean value of household size of six (6). Folorunso *et al.* (2016) reported an average household size of five (5).

4.1.4 Stock Size of the Producers

The mean value of stock size (number of birds kept by each farmer) small-scale quail egg producers was 144 and chicken egg producers was 341 as shown in Table 2. Medium-scale quail producers had a mean value of 637 the medium-scale chicken producers had 792. Stock size is known to have correlation with income of the producers; the higher the number of birds kept the more eggs are produced for sale which means more income. The mean value of 341 further confirmed that the chicken poultry farming in the study area was in a small-scale category as shown in the adopted classification of Ajibefun and Daramola (1999) in this study. A possible reason for the small-scale production level is that a number of the producers were at growing stage after been taught the skills and introduced into the business and inadequate capital to reinvest into the production business. Since the production was in small scale category, it is an indication that there are a lot of opportunities in quail and chicken enterprises, because there is room for more investments or expansions of the business. When the investment is increased more products would be supplied to the market for sale thereby increasing the income of producers and the marketers. Ashagidigbi, Sulaiman and Adesiyani (2011) revealed that financial success or profitability of an enterprise depends on the scale of operation of that enterprise.

4.1.5 Sex of the Producers

Male producers were found to be highly dominated both quail and chicken egg enterprises as shown in Table 2. Small-scale producers were found to be 100% males in quail production and 67% in chicken, for medium-scale operators 100% were males in quail production and in chicken egg production 83% were males; this can probably be explained that males as head of family were engaged in quail or chicken farming for additional income and other economic reasons to cater for family needs.

Generally, a number of enterprises in the study area were dominated by males more especially agricultural enterprises. Culture of the inhabitants of the area might influence the dominance because it is known that males hustle for income to cater for the family needs. This result tallies with findings of Lawal, Amolegbe and Abdussalam (2017) that the dominance of males in quail farming was as a result of the quest of the male for additional income that could suffice their family upkeep. Nmadu *et al.* (2014) opined that the dominance of male in poultry business was due to huge sum of money needed to start the business which was difficult for women to source in this part of the world. Sekumade and Owoeye (2017) reported that majority (67.5%) of quail producers were males. Olayinka (2014) reported, the majority 70% of quail farmers were male. Hassan *et al.* (2016) reported a majority of poultry producers to be male with 71 percentages. Odimegwe *et al.* (2015) reported a 90% of chicken egg farmers to be males. Folorunso *et al.* (2016) revealed 71% of chicken farmers were males. Maikasuwa and Jabo (2011) reported a 62% of the poultry farmers to be males.

4.1.6 Marital Status of the Producers

Marital status is the (legal) conjugal status of each individual in relation to the marriage laws or customs of the country (UN, 2015). It was found that all the small-scale quail producers were married (100%) while chicken egg producers constitute 67% married.

Medium-scale quail production the operators were 97% married and in chicken egg production they constitute 80% married. As discovered earlier the small-scale quail farmers were married men which affirmed the earlier explanation as males as head of the family takes quail farming as a secondary occupation for gaining additional income to cater for family needs. Majority of those engaged in poultry were in for additional income sources. Further comparison reveals the dominance to be more in quail than in chicken production, this could be explained that there are more youth in chicken production due to various empowerment programmes for the youths in the study area. Similar findings like that of Adeniyi and Oguntunji (2011) revealed a 75% of rural poultry farmers to be married. Olayinka *et al.* (2014) reported a majority of 75% quail farmers to be married. Sekumade and Owoeye (2017) reported a 68.8 percent of the quail producers were married. Hassan *et al.* (2016) reported a 64% of poultry farmers were married. Odimegwe *et al.* (2015) reported 77.5% of chicken egg farmers to be married. Folorunso *et al.* (2016) revealed a percentage of 85 poultry producers to be married. Maikasuwa and Jabo (2011) reported 56% of poultry producers were married.

4.1.7 Education Level of the Producers

Education is believed to influence adoption of new techniques in agricultural production practices. The result revealed that all the quail and chicken egg farmers were educated majority of which have tertiary education as shown in Table 2; 72% of the small-scale quail producers had tertiary education and 51.2% of the small-scale chicken egg producers had tertiary education. Medium-scale operators have 65.7% and 63% tertiary education for quail and chicken egg producers respectively. It was clear that there was positive relationship between the level of education and quail and chicken egg farming. Education is seen to play here because there is higher percentage in quail production which is a testimony of educational influence on adoption of new or improved

agricultural practices. The area of the study is inhabited by highly educated population a reason why quail farming is highly practiced there. According to Ali and Samad (2013), level of farmers education is known to affects their farming activities. Olayinka *et al.* (2014) reported 90% of the quail farmers have tertiary education. Nmadu *et al.* (2014) reported percentage of tertiary education among poultry farmers of 56%. Lawal *et al.* (2017) reported 66% of quail farmers had tertiary education which determines their exposure to practice quail farming. It was revealed by Sekumade and Owoeye (2017) that 80 percent of the quail producers had tertiary education. Odimegwe *et al.* (2015) reported that 89.2% of chicken egg farmers have tertiary education. Maikasuwa and Jabo (2011) also revealed 82% poultry farmers having tertiary education. But Folorunso *et al.* (2016) reported 92% poultry farmers were having primary education.

Socio-economic characteristics of the quail and chicken egg marketers are presented in Table 3. The result shows a slight difference between the mean age of the retailers, 38 years and 39 years for quail and chicken egg, respectively, and also in both quail and chicken egg wholesalers 39 and 41, respectively. Age is believed to be correlated with years of experience, the higher the years of experience the more successful marketers are. On comparison there exist slight differences in the years of experience among both the retailers and wholesalers.

4.1.8 Age Structure of the Marketers

The mean age values of 38, 39, 39 and 41 years implied that both the retailers and wholesalers were in their economically active years. It was noticed that all the marketers deal in combination of the two products, which is quail and chicken eggs. At these ages the marketers were active enough to combine the marketing of quail with chicken eggs together. Active age can have positive impact on the marketing business (Afolabi, 2007). Okpeke and Ellah (2017) reported number 39 years as egg marketers'

average age. Nse-Nelson *et al.* (2017) revealed that 51% of poultry farmers were in the range of 21 to 30 years. Asogwu and Okwoche (2012) reported a predominant marketer's age of between 31 to 40 years. Mohammed *et al.* (2013) believed that an active age can positively affect quail marketing. Mere *et al.* (2017) revealed that 50% of marketers were within range of 41 to 60 years.

4.1.9 Experience of the Marketers

Years of experience of quail and chicken egg retailers were 5 and 7 years on the average respectively and for quail and chicken egg wholesalers were 6 and 10 years on the average respectively. The differences in the years of experience were expected as observed; it was higher in chicken egg marketing since chicken egg production started in the area decades long before the quail. The result revealed that majority of the marketers has gathered an experience in marketing of quail and chicken egg. Ekunwe and Alufohai (2009) reported an average of 11 years marketing of chicken egg. Akarue and Isene (2014) reported 1 to 5 years of experience of marketing experience. Okpeke and Ellah (2017) revealed 32 years of experience. Nse-Nelson *et al.* (2017) revealed 6 to 10 years of experience in poultry marketing. Mere *et al.* (2017) in their report 10 years was reported as years of experience.

4.1.10 Household Size of the Marketers

Household size of retail quail egg marketers was found to have mean value of six (6) and five (5) for chicken egg retailers, this revealed that majority of the marketers were married with children. And do not have very large family size.

Table 3: Socio-economic Characteristics of Quail and Chicken Egg Marketers

Variable	Retailers				Wholesalers			
	Quail		Chicken		Quail		Chicken	
	Freq	%	Freq	%	Freq	%	Freq	%
Age								
20 – 29	10	28	11	31	8	25	7	22
30 – 39	10	28	8	22	11	34	11	34
40 – 49	14	39	15	42	6	19	9	28
50 – 59	2	6	2	6	7	22	2	6
60 – 69	0	0	0	0	0	0	1	3
Mean	38		39		39		41	
Years of Experience								
1 – 4	17	47	10	28	12	38	7	22
5 – 8	15	42	13	36	13	41	5	16
9 – 12	3	8	10	28	7	22	11	34
13 – 16	0	0	3	8	0	0	3	9
17 – 20	0	0	0	0	0	0	6	19
Mean	5		7		6		10	
Household size								
1 – 3	10	28	15	42	10	69	24	75
4 – 6	18	50	13	36	13	41	7	22
7 – 9	3	8	6	17	2	6	1	3
10 – 12	3	8	1	3	1	3	3	9
13 – 15	2	6	1	3	6	19	4	13
Mean	6		5		8		6	
Volume of sales								
30 – 59	36	100	26	72	22	69	0	0
60 – 89	0	0	10	28	1	3	6	19
90 – 119	0	0	0	0	0	0	12	38
120 – 149	0	0	0	0	1	3	10	31
150 – 179	0	0	0	0	8	25	4	13
Mean	13		56		84		125	
Sex								
Male	35	97	35	97	32	100	32	100
Female	1	3	1	3	0	0	0	0
Marital status								
Single	4	12	4	12	0	0	0	0
Married	32	88	32	88	32	100	32	100
Education level								
Informal Islamic	0	0	0	0	1	3.1	1	3.1
Primary	2	6	2	6	2	6.3	2	6.3
Secondary	9	25	9	25	17	53.1	17	53.1
Tertiary	25	70	25	70	11	34.4	11	34.4
Adult	0	0	0	0	1	3.1	1	3.1
Total	36	100	36	100	32	100	32	100

Wholesalers have an average family size of eight (8) for quail and six (6) for chicken egg marketers as shown in Table 3. The marketers were possibly engaged in marketing of quails and chicken egg for employment and income generation to cater for familial needs. This result complements that of Ekunwe and Alufohai (2009) who reported an average household size of 6 persons. Mere *et al.* (2017) reported the marketers having between 6 to 10 numbers of persons under their care as constituted 58.5% of them. Okpeke and Ellah (2017) revealed an average of 5 household sizes among the poultry marketers. Nse-Nelson *et al.* (2017) reported average of 4 to 6 household size of poultry marketers.

4.1.11 Volume of Sales

Volume of sales indicated the quantity of quail and chicken egg sold per week in crates by the marketers. Table 3 shows the mean value of 13 crates for quail retailers and 56 crates per week for chicken egg retailers, respectively. There were large variations in quantities sold and this might be as result of capital invested by the individual egg retailer. Wholesalers have mean value of 84 and 125 crates of egg marketed per week for quail and chicken respectively. Expansion or increase in investment by producers would automatically affects the marketing activities as a result of inflow of more products into the market.

4.1.12 Sex of the Marketers

Sex of the marketers as shown in Table 3 indicated 97% of the quail and chicken egg retailers were males while 100% of the quail and chicken eggs wholesalers were all males. It was further discovered that males dominated quail industry in both production and marketing aspects. Males are head of the family with responsibilities to cater for. Mohammed, A. B., Mohammed, S. A., Ayenlare and Afolabi (2013) reported a dominance of 70% males in poultry marketing. Contrary to the finding of

this research, Afolabi (2007), Ekunwe and Afoluhai (2009) and Akurue and Isene (2014) all reported dominance of female in poultry marketing, which may possibly be as result of differences in the production scales found in North and Southern parts of Nigeria where the researches were conducted. Okpeke and Ellah (2017) also reported dominance of females having 71%. But Mere, Aler and Ezihe (2017) reported 58.5% dominance of males in egg marketing. Nse-Nelson, Kurumah and Osundu (2017) reported a dominance of male with 55%. It can further be explained when comparing the involvement of females in the previous researches with what was found now in this study; earlier explanation still holds on men in the study area usually dominates business activities and generally in northern part of Nigeria due to cultural and religious influence.

4.1.13 Marital Status of the Marketers

Marital status of the respondent was found that 88% of the quail and chicken egg retailers were all married and 100% of both the quail and chicken egg wholesalers were all married also, this was an indication that quail and chicken egg marketing is a reliable and employable business providing employment opportunities to earn livelihood for sustaining the family since it was very clear almost all the sampled marketers have family responsibilities to cater for. It further means a possible full-time occupation dominated by married and responsible people. Mere *et al.* (2017) reported 78.5% of poultry marketers were married. Okpeke and Ellah (2017) revealed 50% of egg marketers as married. Afolabi (2007) reported 90% of marketers were married. Ekunwe and Alufohai (2009) reported an 88.3% of marketers were married. 95 % of marketers were married (Mohammed *et al.*, 2013). Akarue and Isene (2014) also reported dominance of married people in poultry marketing.

4.1.14 Education Level of the Marketers

Educational status of quail and chicken egg retailers showed no difference. 70% of the retailers had tertiary education as shown in Table 3; 53.1% of wholesalers had secondary education. It was observed that those engaged in quail enterprise were more educated. As explained earlier education of respondents positively influence adoption of new innovations, techniques and improved practices. Afolabi (2007) reported 70.5% literate poultry marketers. Asogwa and Okwoche (2012) reported a 54% of marketers had secondary education. Akarue and Isene (2014) reported that 69% of the marketers have at least secondary education. (2015) reported a 67.5% of marketers had tertiary education. Okpeke and Ellah (2017) revealed 30% egg marketers had tertiary education. Nse-Nelson *et al.* (2017) reported 63% of egg marketers had tertiary education and Mere *et al.* (2017) revealed 69.2 % of poultry marketers had tertiary education.

4.2 TECHNICAL, ALLOCATIVE AND ECONOMIC EFFICIENCY IN QUAIL AND CHICKEN EGG PRODUCTION

4.2.1 Maximum Likelihood Estimates of Stochastic Frontier production Function

Maximum Likelihood Estimates (MLE) of Stochastic Frontier Production for both quail and chicken egg productions were attained using FRONTIER Version 4.1 Software presented in Table 4. It shows how efficient the eggs producers are in the use of resources in Kano metropolis. Efficiency in the use of farm resources is concerned with the relevant performance of the processes used in transforming given inputs into outputs (Ezeh *et al.*, 2012). Technical efficiency is the effectiveness with which a given set of inputs is used to produce an output. A firm is said to be technically efficient if it is producing the maximum output from the minimum quantity of inputs (Pettinger, 2017). The coefficients of stock size (β_1) were positive in the two scales of quail and chicken egg productions.

Ten percent increase in stock size will lead to an increase in output of quail and chicken eggs of 8.2% and 6.7% in small-scale production respectively; in medium scale it would increase by 6.5% and 2.6% in quail and chicken egg respectively. In comparison it appeared that increase in the stock size would increase efficiency more especially in quail where the estimated output percentage increase is higher. In both scales of productions, the number of stock size ought to be increased. Therefore, increase in stock size would increase the technical efficiency.

The quantity of eggs to be produced depends on the number birds kept. Ezeh *et al.* (2012) and Nmadu *et al.* (2014) all reported positive coefficients of stock size. There must be stock of birds in both quail and chicken egg productions. Ashagidgbi *et al.* (2011) revealed that success of an enterprise depends on the level of operation of enterprise that is higher input utilization gives higher profit.

Coefficients of feed (β_2) were negative in small and medium scale chicken but positive in small and medium scale quail egg production. The positivity in quail production implies that increase in feed consumed would bring about increase the quantity of eggs produced. This is true because it is the feed that was biologically converted into eggs; therefore, increase in ten percent of feed consumed would bring about 2.3% and 3.0% increase in quantity of quail eggs produced in small and medium scale operation respectively. In the case of the negativity in chicken egg production it implied that increase in quantity of feed consumed would reduce efficiency in production. Increase in 10% of feed consumed would lead to a decrease in quantity of chicken egg produced by 4.8% and 1.6% in small and medium scale respectively. The negative coefficients of feed consumed in the small and medium-scale chicken egg production implied that, there was over utilization of feed in the production.

Table 4: Parameter Estimates of Stochastic Frontier (Technical) Production Function for Quail and Chicken Egg Production.

Variables	Small-scale						Medium-scale						
	Quail			Chicken			Quail			Chicken			
Stochastic Function	Par.	Coef.	Std error.	t-stat.	Coef.	Std error.	t-stat.	Coef.	Std error.	t-stat.	Coef.	Std error.	t-stat.
Constant	β_0	0.7184	0.6070	0.1184	0.1364	0.9824	0.1390	0.1033	0.8113	0.1273	0.2401	0.7825	0.3068
Stock size	β_1	0.8215	0.5569	0.1475	0.6693	0.9020	0.7420	0.6479	0.5721	0.1132	0.2612	0.5847	0.4468
Feed	β_2	0.2328	0.3606	0.6457	-0.4815	0.9155	-0.5259	0.3035	0.2037	0.1490	-0.1634	0.4031	-0.4053
Labour	β_3	-0.3874	0.3994	-0.9701	-0.2201	0.9999	-0.2201	0.1129	0.1506	0.7499	0.1435	0.2668	0.5377
Water	β_4	0.1650	0.1481	0.1114	0.7184	0.5966	0.1204	0.2317	0.5591	0.4143	-0.1009	0.2595	-0.3889
Inefficiency Model													
Constant	δ_0	-0.1170	0.4200	-0.2786	0.1128	0.9386	0.1202	-0.6916	0.9272	-0.7460	-0.2704	0.4224	-0.6402
Credit access	δ_1	-0.2184	0.1551	-0.1408	0.8556	0.7879	0.1086	0.8844	0.8685	0.1018	-0.8140	0.9621	-0.8461
Age	δ_2	0.5700	0.1038	0.5494	0.0000	0.1000	0.0000	0.2121	0.2642	0.8226	-0.2509	0.1420	-0.1767
Education	δ_3	0.7346	0.3119	0.2355	-0.1925	0.8180	-0.2352	-0.1309	0.1110	-0.1180	0.4177	0.8556	0.4882
Experience	δ_4	0.3455	0.1478	0.2338	-0.3613	0.9544	-0.3786	0.1623	0.1025	0.1583	0.8040	0.3873	0.2076
Sex	δ_5	0.9543	0.3982	0.2397	0.1628	0.9842	0.1655	-0.2280	0.1120	-0.2036	0.1090	0.8007	0.1362
Membership of Assoc.	δ_6	0.0000	0.1000	0.0000	-0.2078	0.9937	-0.2091	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variance Parameter													
Sigma squared	σ^2	0.1197	0.4552	0.2629	0.6388	0.1892	0.3377	0.1882	0.9172	0.2052	0.5964	0.2074	0.2875
Gamma	γ	0.9994	0.6218	0.1607	0.1104	0.1221	0.9042	0.9427	0.3976	0.2370	0.2328	0.6377	0.3651

In similar research conducted by Nmadu *et al.* (2014) reported negative coefficients of feed consumed but Ezeh *et al.* (2012) reported a positive coefficient of feed consumed.

Coefficients of labour (β_3) were negative in small-scale quail and chicken production but positive in medium scale quail and chicken egg production. This implies that labour was over utilized and increase in it would further decrease efficiency in small scale quail and chicken egg production while labour increase in medium scale operation would increase the output in egg production. Okpachu and Madu (2017) reported a positive labour input in egg production; this result from adequate labour utilization in terms of ensuring sanitization, feeding of higher number of birds.

Coefficients of water (β_4) were positive in small scale quail and chicken egg production also positive in medium scale quail egg production but negative in medium scale chicken egg production, this means more quantity of water for the birds would increase the quantity of eggs produced; it is known that roughly 74% of an egg is made from water and in every aspect of poultry metabolism water is involved.

The efficiency effects of credit access (δ_1) were negative in small scale quail and medium-scale chicken egg production, implying that credit access positively affects farmers' technical efficiency; access to credit would enable the producers employ more inputs to expand the business. Contrary to the expectation, access to credit was positive in small-scale and medium scale quail implying that inability of the operators to access credit would not allow them to increase input usage. Accessibility to credit may increase production efficiency because it would facilitate acquisition of more inputs which will increase output in both egg productions (Ezeh *et al.*, 2012).

Coefficient of age (δ_2) was negative in medium-scale chicken egg production, implying that age of the farmers positively affects the efficiency in the egg

production. In contrary to the expectations; age (δ_2), education (δ_3), experience (δ_4), sex (δ_5) and membership of association (δ_6) all appeared positive in small-scale quail operation; sex was also positive in small scale and medium-scale chicken production; these variables according to this study contributes to inefficiency in the production, possible explanations here were that, looking at the age of the operators we can see the dominance of adults producers, on education too we discovered the dominance of tertiary education dominance also exists in experience and sex where males dominated the enterprises. Comparing this dominance with the producers' inputs combinations which is inadequate for instance overutilization of some critical inputs like labour and feed. We would deduce that they do not affect efficiency of the producers. Normally, efficiency increases with increase in age of farmers which means more age more experience and experience usually improves productivity. We can see in Table 4 that education (δ_3) was negative in small-sale chicken and medium-scale quail egg productions and experience was negative only in small-scale chicken production this means higher level of education and experience positively increase efficiency in production. This was different probably due to higher stock size among these groups.

Membership of association (δ_6) was negative in small-scale chicken production but positive in small-scale quail and medium-scale quail and chicken egg production. Findings of this study agrees and disagrees with some previous findings as Ezeh *et al.* (2012), Ali and Samad (2013) and Girei *et al.* (2013) reported negative coefficients of farmers age, affirming age increases production efficiency. Ezeh *et al.* (2012) reported a positive coefficient for education. But Girei *et al.* (2013) reported negative coefficient for education. Ali and Samad (2013) also reported negative coefficient for education. Ezeh *et al.* (2012) reported a positive coefficient of farming experience.

Ali and Samad (2013) and Ezeh *et al.* (2012) reported positive coefficients of sex. Chiona, Kalinda and Tembo (2014) reported a positive coefficient of membership of association. Ezeh *et al.* (2012) reported a negative coefficient of membership of association. Membership of association positively affects egg production, if quail farmers join or form an association that will increase their efficiency which enables them to access credit.

Diagnostic statistics

The t-ratio of stock size in small-scale quail was significant at 90% confidence interval was not significant in the other three groups; feed is positive in small-scale quail egg production significant at 75% confidence interval but 60% confidence interval chicken egg production; labour was negative in small-scale quail and chicken egg production significant at 75% and 60% confidence interval, respectively but positive in medium-scale production and insignificant; water was positive in quail and chicken small-scale but negative in medium-scale chicken production also non-significant. Only Z_1 was significant at $\alpha = 0.9\%$ in small-scale quail but insignificant in the other groups production. Z_2 was non-significant in all the category of producers. Z_3, Z_4 and Z_5 were positive in small-scale quail egg production and significant at $\alpha = 0.40\%$. Z_3 and Z_6 were negative and significant at $\alpha = 0.40\%$ in small-scale chicken production and Z_5 was negative and significant at $\alpha = 0.40\%$. Z_6 was negative and significant at $\alpha = 0.25\%$ for small-scale chicken.

The sigma squared (σ^2) as shown in Table 3 has the estimates of 0.1197, 0.6388, 0.1882 and 0.5964 for small-scale quail, chicken, medium-scale quail and chicken egg producers, respectively. Small-scale quail and medium-scale chicken were significant at $\alpha = 0.9\%$ and $\alpha = 0.40\%$, respectively indicating a goodness of fit and correctness of the distributional form assumed for the composite error in the model. The value of

gamma (γ) indicates the proportion of variations in the model that is due to capacity utilization. Table 4 shows 0.9994, 0.2629, 0.9427 and 0.2328 as the gamma values or estimates for small-scale quail, chicken, medium-scale quail and chicken egg production, respectively significant at $\alpha = 0.9\%$, meaning 99.9 and 94.3 percent of variations in output of small and medium scale quail egg production among the sampled producers were attributed to technical inefficiency, in other words were due to differences in technical efficiency. Girei *et al.* (2013) reported a gamma value of 90 percent variations. Asogwa *et al.* (2011) revealed 99% variations indicated by gamma estimates. Adinya, Offem and Ikpi (2011) reported 73% variations indicated by gamma estimates. Ali and Samad (2013) reported 63% variations. Ezeh *et al.* (2012) reported 95% variation explained by gamma estimates.

4.2.2 Technical Efficiency Distribution of Quail and Chicken Egg Producers

Summary of the technical efficiency scores of the respondents is presented in Table 5 for the four groups of egg producers. The mean technical efficiency was 0.91, 0.99, 0.90 and 0.94 for small-scale quail, chicken and medium-scale quail and chicken egg production, respectively. Meaning the producers was 91%, 99%, 90% and 94% technically efficient, respectively. The maximum efficiency scores of the four groups were 0.99 except in medium-scale quail with 0.98 that is 99% and 98% technically efficient, respectively. The producers were efficient due to their ability to manage the production process themselves.

It was found as shown in Table 5, that medium-scale chicken egg producers all fall within same range of 0.90 - 0.99 efficiency. This has to do with their being members of an association in which they operate as one; they were sharing same ideas, receiving same experts' advice from their member experts.

Table 5: Distribution of Technical Efficiency Scores in Egg Production

Efficiency Level	Small-scale				Medium-scale			
	Quail		Chicken		Quail		Chicken	
Range	Frequency	%	Frequency	%	Frequency	%	Frequency	%
0.10 – 0.49	1	2.3	25	58	1	2.9	0	0
0.50 – 0.59	0	0	0	0	0	0	0	0
0.60 – 0.69	1	2.3	0	0	0	0	0	0
0.70 – 0.79	3	7.0	0	0	0	0	0	0
0.80 – 0.89	6	14	0	0	10	28.6	0	0
0.90 – 0.99	32	74.4	18	42	24	68.6	35	100
Total	43	100	43	100	35	100	35	100
Maximum	0.99		0.99		0.98		0.99	
Minimum	0.37		0.10		0.35		0.90	
Mean	0.91		0.99		0.90		0.94	

Source: Computer output (Frontier 4.1 output)

The most efficient farmer in the group was having 0.99 efficiency score. On comparing the mean efficiencies of the producers, it was clear that chicken egg producers were more efficient technically than the quail egg producers probably because they keep higher stock, have more experience or belonging to an association which give them an advantage over the quail producers. The mean values of 0.91, 0.99, 0.90 and 0.94 implied that the small-scale quail and chicken medium scale quail and chicken egg producers were 91%, 99%, 90% and 94% technically efficient. In a similar study Girei *et al.* (2013) reported a mean efficiency of 71%. Ezeh *et al.* (2012) and Ali and Samad (2013) reported a mean technical efficiency of 75%. Adinya *et al.* (2011) reported 73% mean efficiency.

4.2.3 Maximum Likelihood Estimate of Stochastic Frontier Allocative (Cost) Function

Maximum Likelihood Estimates (MLE) of Stochastic Frontier Allocative (Cost) Function is presented in Table 6. It shows how efficient the quail and chicken egg producers were in the use of resources with respect to price of inputs in Kano metropolis. Allocative efficiency indicates how different inputs with respect to prices were combined to produce different outputs; it occurs when the output of production is as close as possible to the marginal cost.

The allocative coefficients of birds (β_1) were positive in both quail small and medium-scale egg production but negative in both small and medium-scale chicken production. This implies that increase in the stock size will increase the allocative efficiency in quail egg production while it would cause allocative inefficiency to increase in the case of chicken egg production. Coefficients of cost of feed were all positive in all the four groups of the egg producers implying that increase in the purchase of feed would increase the allocative efficiency of the producers.

Labour and water coefficients were all positive in small-scale quail, chicken and medium-scale chicken egg productions but negative in medium-scale quail egg production; this implies that medium-scale quail producers were not allocatively efficient in the use of labour and water probably they were over utilizing the two inputs. Increase in labour and water would increase allocative efficiency of the small-scale quail and chicken as well as medium-scale chicken producers.

For example, increase in 1% of feed used will bring about 0.21 % and 0.50% increase in cost efficiency of small-scale quail and chicken egg production respectively. Looking critically on Table 6, it can be seen clearly that birds and feed constituted the majority among the inputs. The effects of credit access (δ_1) on allocative efficiency were positive only in small-scale quail egg production, but negative in small-scale chicken and medium-scale quail and chicken egg production. This means access to credit reduces allocative inefficiencies in small-scale chicken and in medium-scale quail and chicken egg productions; this is true because access to credit would enable acquisition of more inputs to make the combinations balanced. Age was both positive in small-scale quail and chicken egg production but negative in the medium-scale egg production of quail and chicken, meaning increase in age reduces allocative efficiency in the small-scale productions which is possible because the quail enterprise was

dominated by adults at older age productivity may be reduced due to decline in the ability to provide needed coordination in the production processes. Coefficients of education and years of experience were all negative in the four groups of producers, meaning that education level and years of experience reduces allocative inefficiency, which are the farmers become more efficient allocatively with increase in level of education and years of experience. Sex of the producers as shown in Table 6, appeared positive in all the quail groups but negative in the chicken groups meaning that involvement of women or females would increase the allocative efficiency of the chicken egg producers while continued dominance of males in quail production would further reduces allocative efficiency in the production.

Coefficients of membership of association were positive in the quail egg productions whereas negative in the chicken egg productions meaning, belonging to an association will increase the allocative efficiency of the chicken egg producers; for the quail producers it implied that as long as they do not form an association, they would continue to remain allocatively inefficient.

Table 6: Parameter Estimates of Stochastic Frontier Allocative (Cost) Function for Egg Production.

Variables	Par.	Small-scale						Medium-scale					
		Quail			Chicken			Quail			Chicken		
Stochastic Function		Coef.	Std error.	t-stat.	Coef.	Std error.	t-stat.	Coef.	Std error.	t-stat.	Coef.	Std error.	t-stat.
Constant	β_0	0.1143	0.2383	0.4795	0.9128	0.9407	0.9703	0.9532	0.5558	0.1715	-0.2382	0.9958	-0.2392
Cost of Birds	β_1	0.4811	0.8266	0.5820	-0.1042	0.3567	-0.2956	0.2173	0.6466	0.3361	-0.1298	0.8837	-0.1469
Cost of Feed	β_2	0.2132	0.6598	0.3231	0.5045	0.2761	0.1827	0.1315	0.4048	0.3247	0.7182	0.7998	0.8980
Cost of Labour	β_3	0.1721	0.1201	0.1433	0.4351	0.3340	0.1303	-0.6711	0.8254	-0.8131	0.4709	0.8762	0.5374
Cost of Water	β_4	0.2382	0.2182	0.1092	0.3428	0.4610	0.7436	-0.3435	0.4026	-0.8532	0.5658	0.9058	0.6247
Inefficiency Model													
Constant	δ_0	0.6105	0.1959	0.3136	-0.3402	0.9173	0.2621	0.3009	0.3222	0.9338	-0.1182	0.9810	-0.1205
Credit access	δ_1	0.2282	0.1056	0.2161	-0.3402	0.7733	0.4400	-0.6042	0.1360	-0.4441	-0.2024	0.9428	-0.2146
Age	δ_2	0.6161	0.2958	0.2080	0.0000	0.1000	0.0000	-0.3366	0.2378	-0.1415	-0.3558	0.9983	-0.3564
Education	δ_3	-0.2999	0.3865	-0.7758	-0.2987	0.8137	-0.3671	-0.1716	0.2118	-0.8100	-0.1853	0.9516	-0.1947
Experience	δ_4	-0.5153	0.6933	-0.7433	-0.1335	0.9787	-0.1364	0.1785	0.8314	0.2146	-0.6464	0.9944	-0.6501
Sex	δ_5	0.3613	0.9183	0.3934	-0.7797	0.9663	-0.8070	0.7425	0.6129	0.1211	-0.1027	0.9871	-0.1040
Membership of Assoc.	δ_6	0.0000	0.1000	0.0000	-0.8823	0.9976	-0.8846	0.0000	0.1000	0.0000	-0.7838	0.9999	-0.7839
Variance Parameter													
Sigma squared	σ^2	0.1972	0.3846	0.5128	0.2157	0.2153	0.1002	0.6227	0.1693	0.3679	0.4266	0.8532	0.4999
Gamma	γ	0.7731	0.9772	0.7911	0.9999	0.4082	0.2450	0.3114	0.4682	0.6652	0.1713	0.7558	0.2267

In similar research Girei *et al.* (2013) reported a positive coefficient of cost of labour and water but negative coefficients of experience, education and age. Asogwa *et al.* (2011) reported a negative coefficient of age, Hossain *et al.* (2015) positive years of experience.

Diagnostic statistics

The t-ratios of cost of labour and water were significant at 90% confidence interval for small-scale quail egg production, cost of feed and labour in small-scale chicken egg production were significant at 90% confidence interval. Credit access and age were significant at $\alpha = 0.40$ while education and experience were significant at $\alpha = 0.9$ confidence level in small-scale quail production. Education and sex were significant $\alpha = 0.9$ confidence level. Credit access and experience were significant at $\alpha = 0.40$ confidence level

The sigma squared (σ^2) indicate the goodness of fit and correctness of the distribution form assumed for composite error term; it has the estimates of 0.1972, 0.2157, 0.6227 and 0.4266 for small-scale quail and chicken egg and medium-scale quail and chicken egg productions respectively. The value of gamma (γ) indicates the proportion of variations in the model that is due to capacity utilization. Table 5 shows 0.7731, 0.9999, 0.3114 and 0.1713 as the gamma values or estimates for small-scale egg production, meaning 77.31, 99.99, 31.14 and 17.13 percent of variations in allocative efficiency of small-scale quail and chicken and medium-scale quail and chicken egg production respectively among the sampled producers were attributed to allocative inefficiency, in other words were due to differences in allocative efficiency of the producers.

4.2.4 Allocative Efficiency Distribution of Quail and Chicken Egg Producers

Summary of the allocative efficiency scores of the respondents is presented in Table 7. The mean allocative efficiencies of small-scale farmers were 0.10 and 0.11 in quail and chicken egg production respectively; this indicates that quail producers were 10% and chicken egg producers were 11% allocatively efficient in production. In medium-scale production both quail and chicken egg producers were having 0.10 efficiency score meaning they were 10% efficient in inputs cost combination. As indicated in Table 7 all the four categories of producers fall within 0.10 – 0.46 cost efficiency range with the most efficient farmer having 0.12 allocative efficiency score in small-scale chicken egg production.

Table 7: Allocative (Cost) Efficiency Scores in Egg Production

Efficiency	Small-scale				Medium-scale			
	Quail		Chicken		Quail		Chicken	
	Freq	%	Freq	%	Freq	%	Freq	%
Range	43	100	43	100	35	100	35	100
Total	43	100	43	100	35	100	35	100
Maximum	0.11		0.12		0.11		0.10	
Minimum	0.10		0.10		0.10		0.10	
Mean	0.10		0.11		0.10		0.10	

Source: Computer output (Frontier 4.1 output)

These results suggest that there are lots of opportunities for the egg producers to enhance their efficiencies through investing more and expanding of the egg enterprises. Sourcing for more capital would enable the producers to reinvest and better up their businesses. It appeared that the egg producers were using inputs in almost same proportions probably due to belonging to one group or the other or being guided by expert or professional advices. Asogwa *et al.* (2011) reported 1.65 mean allocative efficiency. Girei *et al.* (2013) revealed allocative mean efficiency of 0.76.

Umar *et al.* (2015) discovered an allocative efficiency mean of 0.54. Ouattara (2012) reported allocative efficiency score of 0.66.

4.2.5 Economic Efficiency Distribution of Quail and Chicken Egg Producers

Table 8 shows the economic efficiency scores of the quail and chicken egg producers and were obtained as the product of technical and allocative efficiencies of the producers. The mean value of economic efficiency scores in both small-scale quail and chicken egg production were 0.091 meaning that the small-scale operators were economically efficient in production which present opportunities for improvement through expanding the investment to a large scale operation. Medium-scale quail and chicken egg producers had 0.090 and 0.094 economic efficiency scores respectively. On comparison one can depict that chicken egg producers appeared to be more efficient economically than the quail egg producers, in 0.100 to 0.120 economic efficiency levels, small-scale chicken egg producers had 27.9% while quail egg producers had 0% whereas in medium-scale production, chicken egg producers had 97.1% while quail egg producers had 74.3% economic efficiency score.

Table 8: Economic Efficiency Scores in Quail and Chicken Egg Production

Efficiency	Small-scale				Medium-scale			
	Quail		Chicken		Quail		Chicken	
	Freq	%	Freq	%	Freq	%	Freq	%
0.010 – 0.050	1	2.3	25	58.1	1	2.9	0	0
0.051 – 0.059	0	0	1	2.3	0	0	0	0
0.060 – 0.069	1	2.3	0	0	0	0	0	0
0.070 – 0.079	3	7.0	0	0	0	0	0	0
0.080 – 0.089	2	4.7	0	0	8	22.9	0	0
0.090 – 0.099	36	83.7	5	11.6	26	74.3	34	97.1
0.100 - 0.120	0	0	12	27.9	0	0	1	2.9
Total	43	100	43	100	35	100	35	100
Maximum	0.099		0.120		0.098		0.100	
Minimum	0.038		0.010		0.035		0.090	
Mean	0.091		0.091		0.090		0.094	

Source: Computer output (Frontier 4.1 output)

Chicken egg producers were more economically efficient probably due to their more years of experience and a greater number of birds kept. Profitability of egg production was found to be correlated with number of birds, therefore profitability of egg production increases with increase in number of birds kept. The wide differences in percentages in all the four groups of producers were due to wide variations in number of birds kept by the individual producers. Egg producers must achieve both technical and allocative efficiencies before achieving economic efficiency become possible. In similar researches Ouattara (2012) reported a mean economic efficiency of 0.522. Girei *et al.* (2013) a mean economic efficiency of 0.5

4.3 COSTS AND RETURN ANALYSIS IN QUAIL AND CHICKEN EGG PRODUCTION AND MARKETING

4.3.1 Costs and Return Analysis in Quail and Chicken Egg Production

An economic analysis of costs and returns is an indicator of profitability in farming activity. Costs and returns are often a critical factor to be considered once there is a plan to invest in production. Costs and returns analysis were used to evaluate the viability of investment in Quail and Chicken egg production. Results of costs and returns analysis in quail and chicken egg production were summarized in Table 9. The cycle of production in quail egg production was 58 weeks and that of chicken egg was 72weeks.

The Net Farm Incomes (NFI) were ₦244,483, ₦239,009, ₦1,252,376 and ₦550,136 per producer for small-scale quail, chicken and medium-scale quail and chicken egg production per cycle, respectively. The gross ratios were estimated at 0.55 for small-scale and 0.48 for medium-scale quail egg production; values which are higher in chicken egg production with 0.91 and 0.90 for small and medium-scales, respectively, these differences were due to the higher cost of inputs in the chicken egg production, these ratios were used to determine the amount of profits made compared to the

operating costs of the eggs production, meaning 55%, 91%, 48% and 90%, respectively, were percentages of total cost to the profits made in the egg productions. The operating ratios were 0.48 and 0.46 for small and medium scale quail egg production, respectively, and 0.88 in both small and medium-scale chicken egg production, these ratios were used to measure the operational efficiency of the egg producers.

A low operating ratio means high net profit ratio. It was clear that the operational profit is high in both small and medium scale egg production; it is the percentage of the profit that would go to pay the total variable cost. The rate of returns ratio was 0.83, 0.11, 1.10 and 0.11 for small and medium scale quail egg and small and medium-scale chicken eggs production respectively. Rate of return is the ratio of the investment's income over the cost of that investment which is the egg production; it is used as a measure of financial or economic success. It can be explained as that for every Naira invested ₦83, ₦11, ₦110 and ₦11 were generated in small and medium scale productions, respectively, which indicates both small and medium scale eggs production were profitable in the study area. On comparison it was clear that quail production was more profitable probably due to shorter production cycle, lower inputs requirement and lower costs of production compared to that of chicken egg production. As shown in Table 9 total costs of productions (TC) were much higher in chicken egg productions where ₦293,567 and ₦2,237,091 were total costs for small-scale quail and chicken egg production, respectively. There were reports on similar studies like that of White (2017) who believed gross ratio is used by businesses to determine the amount of profit made compared to the operating costs of the business.

Table 9: Costs and Returns Analysis in Egg Production per cycle Per Person

Items	Small-scale						Medium-scale														
	Quail			Chicken			Quail			Chicken											
	Average Values	Unit Price (₦)	Amount (₦)	%TVC	%TC	Average Values	Unit Price (₦)	Amount (₦)	%TVC	%TC	Average Values	Unit Price (₦)	Amount (₦)	%TVC	%TC	Average Values	Unit Price (₦)	Amount (₦)	%TVC	%TC	
Var. Costs.																					
No. of birds.	144	150	21,600	8	7.4	341	250	119,350	5.5	5.3	637	150	95,550	8.8	8.4	792	250	198,000	93.2	3.92	
Feed (kg).	1,872	112	209,664	81.9	71.	17,732	112	1,985,984	91.32	88.8	8,281	112	927,472	85.2	81.55	41,184	112	4,612,608	0.4	91.3	
Labour(MD)	1	18,000	18,000	7	6.1	1	18,000	18,000	0.83	0.8	2	18,000	36,000	3.31	3.16	1	18,000	18,000	1.2	0.36	
Water(litres).	4,896	1.25	6,120	2.4	2.1	21,142	1.25	26,428	1.22	1.22	21,658	1.25	27,073	2.5	2.4	49,104	1.25	61,380	1.2	1.21	
Drugs.			1,203	0.5	0.4			24,521	1.1	1.1			1,543	0.14	0.1			60,676	0.02	1.20	
Transp			483	0.2	0.2			508	0.02	0.02			509	0.05	0.04			800	100	0.02	
TVC			255,867	100				2,174,791	100				1,088,147	100				4,951,264	%FC		
FC				%FC					%FC					%FC						6.25	0.13
Drinkers.	2	200	400	1.1	0.1	13	200	2,600	4.2	0.12	6	200	1,200	2.44	0.1	32	200	6,400	5.86	0.12	
Feeders.	2	150	300	0.8	0.1	18	150	2,700	4.3	0.12	6	150	900	1.83	0.1	40	150	6000	41.01	0.83	
Rent.			27,000	71.6	9.2			34,000	54.6	1.52			27,000	55	2.4			42,000	46.88	0.95	
Cage.	2	5,000	10,000	26.5	3.4			23,000	36.9	1	4	5,000	20,000	40.73	1.75			48,000	100	100	
TFC			37,700	100	100			62,300	100	100			49,100	100	100			102,400			
Total Cost			293,567					2,237,091					1,137,274					5,053,664			
Revenue																					
Spent layers	139	300	41,700			403	800	322,400			632	300	189,600			761	800	608,800			
Eggs/cycle	1,103	450	496,350			2,393	900	2,153,700			4,889	450	2,200,050			5,550	900	4,995,000			
Total Rev.			538,050					2,476,100					2,389,650					5,603,800			
NFI			244,483					239,009					1,252,376					550,136			
G R			0.55					0.91					0.48					0.90			
OR			0.48					0.88					0.5					0.88			
R.O.R.			0.83					0.11					1.10					0.11			

Onyewuchi *et al.* (2013) reported that quail egg productions were profitable. Amos (2006) reported a net profit per layer of ₦434 per layer. Haruna *et al.* (2007) reported an operating ratio of 0.6. Nuruddeen (2012) reported that poultry egg production was profitable. Ahmed *et al.* (2014) reported a mean value of egg within a production cycle of ₦4,062,422. Girei *et al.* (2018) reported a total revenue of ₦1,575,362. Odimegwe *et al.* (2015) reported an NFI of ₦2,011,857.16 in chicken egg production. Mere *et al.* (2017) reported an NFI of ₦1,248.

4.3.2 Costs and Return Analysis in Quail and Chicken Egg Marketing

Results of a weekly costs and returns in egg marketing were summarised in Tables 10. The cost of purchase of crates of egg constituted 56% of the cost of quail retail marketing and 83.4% of the cost of egg in wholesale marketing. On the average in retail marketing ₦10, 894 were incurred by a retail quail marketer per week and ₦61,231 were incurred by chicken egg retailer per week. On the average an egg retailer earned ₦12,200 and ₦67,773 per week in quail and chicken egg marketing, respectively.

An average net revenue of ₦18,180 was earned by a wholesale marketer of quail and ₦5,371 was earned by wholesale chicken egg marketer indicating that quail egg marketing is more profitable in Kano metropolis. Similar findings were reported by Afolabi (2007) where egg marketers earned average revenue of ₦25, 822 per month. Ekunwe (2009) reported a gross margin per seller of ₦12, 029.50. Mohammed *et al.* (2013) reported a gross income of an egg marketer of ₦37, 500 per month. Akarue and Isene (2014) reported that an average egg marketer earned ₦47, 951.92 per month. In all those researches poultry marketing was profitable.

Table 10: Costs and Return Analysis in Quail and Chicken Egg Marketing

Items	Retail						Wholesale					
	Amount (₱)	Quail % of TC	% of Total Revenue	Amount (₱)	Chicken % of TC	% of Total Revenue	Amount (₱)	% of TC	Quail % of Total Revenue	Amount (₱)	Chicken % of TC	% of Total Revenue
Cost of Eggs	219,600	56		2,032,000	92		1,212,300	84.3		3,584,700	94	
Transportation Cost	60,600	15.5		60,600	2.7		47,400	3.3		47,400	1.2	
Storage Cost	15,000	3.8		15,000	0.7		4,050	0.3		4,050	0.1	
Tax	97,000	24.7		97,000	4.4		175,000	12.2		175,000	4.6	
Total Cost (TC)	392,200			2,204,600			1,438,750			3,811,150		
Total Revenue	439,200			2,438,400			2,020,500			3,983,000		
Total Cost/Seller	10,894			61,239			44,961			119,098		
Total Revenue/Seller	12,200		2.39	67,733		2.8	63,141		3	124,469		3
Net Revenue/Seller	1,306		0.3	6,494		0.3	18,180		0.9	5,371		0.1
Margin	150			200			300			100		

4.4 STRUCTURE AND CONDUCT OF QUAIL AND CHICKEN EGG MARKETING

4.4.1 Structures of Quail and Chicken Egg Marketing

In determining the structures of the eggs marketing categorization into retailers and wholesalers was not considered because both categories were attending same market. Market structure usually describes whether the number of firms producing a product is large or the firms are of equal sizes or dominated by small group. The estimation was made on the weekly sales of crates of eggs by an individual marketer. Summary of the results of Gini coefficient of quail eggs marketing is shown in Table 11 and that of chicken egg marketing is shown in Table 12.

Table 11 shows that 72% of the quail egg marketers were within income range of ₦5,000 and ₦30,000 weekly while 15% are within range of ₦130,000 and ₦155,000. Mean value of sales was ₦41,889. This implies that on the average a marketer was earning this much from sales of quail egg weekly. Gini coefficient was determined as 0.71 which indicates the existence of 71% inequality among the quail egg marketers. This means an imperfect competitive market which suggests monopolistic market. The monopoly nature of the market might have arisen due to dominance of few marketers which is the reality on ground. Quail marketing in the study area was found to be a monopolistic.

In chicken egg marketing 46% of the marketers fall within income range of ₦40,000 to ₦70,000 while 3% within ₦190,001 to ₦220,000 per week. Average sales to a chicken egg marketer per week was ₦106,482. Gini ratio was estimated as 0.77 which means that there is 77% inequality in size and distribution of chicken egg marketers which suggests imperfect competition. In comparison the percentages of Gini ratios of 76% in quail egg and 77% in chicken egg it was obvious that inequality is almost

same in the two egg marketing giving rise to dominance by some few, thereby monopolizing the market.

Table 11: Gini Coefficients of Quail Egg Marketing in Kano Metropolis

Range of Income (₦)	Frequency of Sellers	Percentage of Sellers(Y)	Cumulative Freq of sellers	Percentage cumulative freq	Total Sales (₦)	% of Total sales(X)	YX
5,000 – 30,000	49	72	49	72	743,400	26	0.1872
30,001 – 55,000	8	12	57	84	351,000	12	0.0144
55,001 – 80,000	1	1	58	85	59,400	2	0.0002
80,001 – 105,000	0	0	58	85	0	0	0.0000
105,001 – 130,000	0	0	58	85	0	0	0.0000
130,001 – 155,000	10	15	68	100	1,694,700	59	0.0885
				Total	2,848,500		$\sum yx = 0.2903$

Mean value of sales = ₦41, 889

Gini coefficient = $1 - \sum yx = 1 - 0.2903 = 0.7097$

Table 12: Gini Coefficients of Chicken Egg Marketing in Kano Metropolis

Range of Income (₦)	Frequency of Sellers	Percentage of Sellers(Y)	Cumulative Freq of sellers	Percentage cumulative freq	Total Sales (₦)	% of Total sales(X)	YX
40,000 - 70,000	31	46	31	46	1,998,000	27.6	0.1270
70,001 - 100,000	15	22	46	68	1,536,000	21.2	0.0466
100,001 –130,000	11	16	57	84	1,550,400	21.4	0.0342
130,001 – 160,000	8	12	65	96	1,422,000	19.6	0.0235
160,001 – 190,000	1	1	66	97	194,000	2.7	0.0003
190,001 – 220,000	2	3	68	100	540,000	7.6	0.0023
				Total	7,240,800		$\sum yx = 0.2339$

Mean value of sales = ₦106,482 Gini coefficient = $1 - \sum yx = 1 - 0.2339 = 0.7661$

In similar researches by Nse-Nelson *et al.* (2017) reported a Gini coefficient of 0.50. Ekunwe and Alufohai (2009) reported a Gini ratio of 0.81 and Afolabi (2007) reported a Gini ratio of 0.87.

4.4.2 Market Conduct

Market conduct refers to the pricing and promotion strategies followed by both quail and chicken egg producers and marketers in the market in terms of their aims and objectives. Conditions believed to depict exploitative relationship between producers and buyers were used to determine the conduct of the quail and chicken egg producers and marketers in the study area. The quail market is characterized by small number of producers and marketers even on the few producers there were few major ones likewise on the marketers' side. Supply of eggs was not enough thereby given room to the producers to fix the price. Sometime in face of low demand for quail eggs marketers tend to influence the price especially the major ones. There was inadequate information in both sides of the producers and the marketers given room for suspicion and collusion to exist.

It was discovered that quail producers in the study area has no formal association, hence, lack power advantage to negotiate as a group to achieve their aims and objectives. All quail producers interact individually with other stakeholders. Most of the time producers determine the price of egg. Major buyers like the major egg dealers also determine the price of the quail egg. In the case of chicken egg producers there exists a formal association which negotiates on their behalf thereby to some extent help in fixing the price of the products. During the study it was observed that price of producing a unit of quail egg as major factor determining the decision to produce the egg and readiness sale to the buyer as indicated in Table 13. Factors that affect price determination by Kalpana (2017) were used.

Table 13: Factors Affecting Price Determination

Factor	Producers				Marketers			
	Quail		Chicken		Quail		Chicken	
	Freq	%	Freq	%	Freq	%	Freq	%
Production Cost.	33	42.3	15	19.2	8	11.8	17	25
Utility/Demand.	20	25.6	25	32.1	34	50	35	51
Competition.	10	12.8	20	25.6	12	17.6	10	14.7
Legal Regulation.	0	0	10	12.8	0	0	0	0
Marketing Methods.	15	19.2	8	10.3	14	20.6	6	8.8
Total	78	100	78	100	68	100	68	100

All the producers and marketers of chicken egg belong to one or other association. Bosená *et al.*(2011), Funke *et al.*(2012), Muazu *et al.*(2013) and Ruttoh *et al.*(2018) posited there are no agreed formula for analyzing market conduct elements but conditions believed to depict exploitative relationship between producers and buyers are normally used.

4.4.3 Marketing Margin of Quail and Chicken Eggs

Marketing margin is the difference in prices paid for quail and chicken egg at different stages of the marketing system. According to Morello (2016), in the agriculture industry, marketing margins has a slightly different meaning. Since produce is grown rather than built or bought wholesale, the marketing margin lies between the prices that a farmer would get selling his or her products directly to a wholesaler at harvest versus the cost of taking it to market and selling it retail. Results of the marketing margins of quail and chicken egg are presented in Table 14.

Share of quail egg producer was 36.67%; wholesaler's share 33.33% and retailer's share was 16.67% also. The price received by farmer (Pf) was ₦15 per egg of quail,

wholesale price was ₦25 an egg and retail price (Pr) was ₦30. The retail margin (Mr) and wholesale margin (Mw) was ₦100 each per crate. Market margin was ₦200. The marketing cost index 'R' was 50 meaning 50% of the retail price of quail egg is related to its marketing costs.

Share of chicken egg producer was determined to be 50%; share of egg wholesaler was 12.5% and share of egg retailer was 12.5 %. Where price received by producers (Pf) was ₦30, whole sale price (Pw) was and retail price ₦35 was ₦ 40. The retail margin (Mr) was ₦300 per crate; wholesale margin (Mw) was ₦10 per egg and ₦100 per crate. The marketing cost index 'R' was 25 meaning 25% of the retail price of crate of chicken egg is related to the cost of marketing the egg.

Looking further at Table 14 it was obvious that cost of inputs was higher in chicken egg production. Retailers and wholesalers were earning more in quail egg marketing but producers earn more in chicken egg. Similar results were revealed by Mabood *et al.* (2014) reported a marketing cost index of 27%. Kohansal and Akbari (2013) reported an index of 25%.

Table 14: Producer price, Wholesale price, Retail price, Share of prices, Marketing margin and Marketing cost Index of Eggs.

Description	Quail			Chicken		
	Producer price	Wholesale price	Retail price	Producer price	Wholesale price	Retail price
Price	₦15	₦25	₦30	₦30	₦35	₦40
Share	36.67%	33.33%	16.67%	50%	12.5%	12.5%
Margin		Wholesale ₦300/crate	Retail ₦150/crate		Wholesale ₦100/crate	Retail ₦200/crate
Marketing cost index		50			25	

4.5 MAJOR PROBLEMS ASSOCIATED WITH QUAIL AND CHICKEN EGG PRODUCTION AND MARKETING

4.5.1 Major Problems Associated with Quail and Chicken Eggs Production

Problems are unwelcome situations or harmful which needs to be handled and overcome. They exist between what is available and what is needed or desired. Problems as experienced by the egg producers were presented in Table 15.

Problem of inadequate information appeared to be the highest one among the major ones affecting quail production in the study area with 69.77% followed by non-natural brooding among the small-scale quail producers while in medium-scale production inadequate information had 68.57% and non-natural brooding had 11.43%. In case of chicken egg production, high cost of feed constitutes 58.14% followed by 30.23% diseases in small-scale production while in medium-scale chicken high cost of feed constitute 65.71% and 20% diseases.

It was observed that diseases prevalence in quail production to be very minimal unlike in chicken production, this is one of the major advantages of quail over chicken; this result agreed with findings of Bakoji *et al.* (2013). There were general believe among quail farmers in the area of study that, quail is excessively resistant to major avian diseases. Many did not experience any disease outbreak which they believed with good sanitation and good management practices disease could be avoided. And possible reason for non-experience could be due to the small number of the birds kept by individuals. It was on record that Kano state was not among the states where quail diseases were identified (Mohammed and Ejiofor, 2015). Aromolaran *et al.* (2013) reported disease and high cost of feed as major problems in poultry production.

Table 15: Major Problems associated with Quail and Chicken Eggs Production

Problems	Small-scale				Medium-scale			
	Quail Frequency	%	Chicken Frequency	%	Quail Frequency	%	Chicken Frequency	%
High cost of feed	2	4.65	25	58.14	5	14.29	23	65.71
Non-available market	2	4.65	1	2.33	1	2.86	0	0
Non-natural brooding	8	18.60	2	4.65	4	11.43	3	8.57
Inadequate information	30	69.77	2	4.65	24	68.57	2	5.71
Diseases/Pests	1	2.33	13	30.23	1	2.86	7	20
Total	43	100	43	100	35	100	35	100

4.5.2 Major Problems associated with Quail and Chicken Eggs Marketing

The major problems faced by marketers were presented in Table 16. Problem of inadequate advertisement appeared to have 55.56% followed by poor sales having 33.33% in quail egg retailing while in chicken retailing inadequate capital had 52.78% followed by poor sales with 22.22%. In quail egg wholesaling, inadequate advertisement had 62.50% followed by 31.25% poor sales. 46.88% of chicken egg wholesalers see inadequate capital as their major problem followed by price fluctuation with 31.25%. In similar research, Mohammed *et al.* (2013) reported 77.5% price fluctuations, 37% inadequate capital and 50% poor sale.

Table 16: Major Problems associated with Quail and Chicken Eggs Marketing

Problems	Retail				Wholesale			
	Quail		Chicken		Quail		Chicken	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Price fluctuation	0	0	5	13.89	1	3.13	10	31.25
Transportation	1	2.78	1	2.78	1	3.13	1	3.13
Poor sales	12	33.33	8	22.22	10	31.25	5	15.63
Inadequate capital	3	8.33	19	52.78	0	0	15	46.88
Inadequate Advertisement	20	55.56	3	8.33	20	62.50	1	3.13
Total	36	100	36	100	32	100	32	100

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The study analyses the Economics of quail and chicken egg production and marketing in Kano metropolis. The objectives were; describe the socio-economic characteristics of quail and chicken egg producers and marketers in Kano metropolis, determine the technical, allocative and economic efficiency in quail and chicken egg production, estimates the costs and returns quail and chicken egg production and marketing in Kano metropolis, describe the structure and conduct of quail and chicken egg marketing in Kano metropolis and describe the problems associated with quail and chicken egg production and marketing in Kano metropolis. Due to the small number of populations of the quail producers and marketers were grouped into small and medium-scale while marketers were grouped into retailers and wholesalers; the entire identified respondents were taken. Chicken egg producers were randomly selected from list of association membership and grouped as in quail. Primary data were collected via use of questionnaire with the assistance of the assistance of some trained enumerators. Data collected were analyzed using descriptive statistics, stochastic frontier analysis, farm budgeting, marketing margin, financial ratios and Gini ratio.

Socio-economic analysis of quail and chicken egg producers and marketers revealed 100% of the small-scale quail producers were male. 67% chicken egg were male and 72% of them had tertiary education. 97% of marketers were male and 70% had tertiary education. The MLE coefficients of feed consumed in small- scale production was positive which implied that increase in feed will increase technical efficiency. There was over utilization of feed in small-scale chicken egg production. In case of

egg production increase in 10% quantity of feed will lead to 2.0% increase in small scale quail egg production. Age, years of experience and membership of association all affects efficiency positively. The allocative inefficiency effects of credit access Z_1 (δ_1) were negative in medium scale egg production, this means access to credit reduces allocative inefficiencies in egg production.

The operating ratios were 0.48 for small-scale quail and 0.88 for chicken egg production. It can be explained that for every Naira invested ₦83 and ₦110 was generated in small-scale and medium scale quail egg productions respectively. ₦11 were generated from naira invested in chicken egg productions, indicating both egg productions were profitable in Kano metropolis. The results of Gini coefficients showed that 72% of the marketers were within income range of ₦5,000 and ₦30,000. Mean value of sales was ₦41, 889. Gini coefficient was determined as 0.71 in quail egg marketing, the value indicating an imperfect competitive market which suggests monopolistic market. The market structures of quail and chicken egg were all determined as monopolistic. 69.77% of quail producers identified inadequate information as major problem in small-scale quail egg production and 55.56% of retail marketers also identified poor advertisement in quail egg marketing as major problem in affecting the enterprise. High cost of feed was identified as major problem in both chicken egg productions.

5.2 CONCLUSION

It was evident that quail enterprises were dominated by males in both production and marketing. Wide variation exists in the number of birds kept among quail producers. All the quail producers take quail production as secondary occupation. Quail and chicken egg business was found to be very profitable. Marketers too have wide gap in

the volume of sales made. Producers were technically efficient in both small and medium scale egg production but allocatively inefficient.

Marketing structure of quail and chicken eggs was both monopolistic in nature and profitable. Quails were believed to be highly resistant to disease. Generally poor knowledge about the quail products constituted the major problem in both production and marketing enterprises.

5.3 RECOMMENDATIONS

Based on the findings of the study, following recommendations are proffered:

1. The Producers are to employ more inputs in order to attain technical, allocative and economic efficiencies.
2. Accessibility to credit would enhance the efficiencies of both producers and marketers. Therefore, government, private sector and other interested donor agencies should provide the credit and other incentives to promote the enterprise.
3. Provision of alternative sources of cheap feed to reduce the cost of production. Government, research agencies and farmers' associations should come up with the alternative.
4. Increase in production of quail and chicken eggs would help in reducing the inequality gap among the marketers. This is possible with large scale operation.
5. Provision of flat form for flow of market information to reduce collusion in the market. For example the producers and marketers can provide an online flat form or create web site for inflow and outflow of information about the enterprises.

6. There should be a sort of national project for promoting quail to bridge the existing gap in the supply of poultry products. Like the 6 mandate crops' policy of the Federal Ministry of Agriculture; quail production can be promoted.

5.4 CONTRIBUTION OF THE STUDY TO KNOWLEDGE

The followings are some of the contributions to knowledge derived from the study:

- 1 Quail egg production is more profitable than Chicken egg. Quail has less inputs requirement and higher net returns in both production and marketing aspects. ₦244,483 and ₦239,009 were net farm income per small-scale quail and chicken egg producer respectively while in medium-scale production the net farm income was ₦1,252,376 and ₦550,136 for quail and chicken egg respectively.
- 2 Quail enterprise was found to be a viable investment option in both production and marketing aspects with potentials of competing with if not substituting Chicken enterprise. For every naira invested ₦83 and ₦11 was return in small-scale quail and chicken egg production respectively. And in medium-scale production ₦110 and ₦11 was returned in quail and chicken egg production respectively. In case of marketing net revenue per retailer was ₦1,306 and ₦6,494 with margin of ₦150 and ₦200 in quail and chicken egg marketing respectively. In wholesaling net revenue was ₦18,180 and ₦5,371 with margin of ₦300 and ₦100 in quail and chicken egg marketing respectively.
- 3 The mean technical efficiency scores was determined as 0.91 and 0.99 in small-scale quail and chicken egg production, respectively, while 0.90 and 0.94 in medium-scale quail and chicken egg production, respectively. In

allocative (cost) efficiency there was no much difference among the producers, the mean values were 0.10 and 0.11 in small-scale quail and chicken egg production, respectively, and 0.10 in medium scale production for both quail and chicken egg production. Medium scale chicken egg producers were more economically efficient than other groups; the mean economic efficiency scores were determined as 0.091 in both small-scale quail and chicken egg production while in medium-scale production it was 0.090 and 0.094 for quail and chicken egg production, respectively.

5.5 SUGGESTED AREAS FOR FURTHER STUDIES

The study proffers suggestions for further studies in the following areas;

1. Perception of commercial chicken producers on adoption of quail production in Kano State.
2. Taste preference between quail and chicken products among the consumers in Kano State.
3. Perception of consumers on quail products.
4. Substitutability of chicken production by quail production in Kano State.
5. Reasons for the decline in the productivity of quail industry in Kano State.

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APPENDICES

APPENDIX I: PRODUCTION: QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION
FACULTY OF AGRICULTURE
POSTGRADUATE RESEARCH QUESTIONNAIRE

TOPIC: ECONOMICS OF QUAIL AND CHICKEN EGG PRODUCTION
AND MARKETING IN KANO METROPOLIS, NIGERIA

PRODUCTION: QUESTIONNAIRE.

INTERVIEWER (Name) _____ DATE _____

Please fill in the space or tick (✓) where applicable

PRODUCER: Quail Eggs []

Chicken Eggs []

SECTION A: SOCIO-ECONOMIC INFORMATION

1. Name of farmer _____ Phone no. _____
2. Local government area _____
3. Age _____
4. Gender: (a) Male [] (b) Female []
5. Marital Status: (a) Single [] (b) Married [] (c) Widowed [] (d) Divorced []
6. Household size _____
7. Education Level (a) Islamic [] (b) Primary [] (c) Secondary (d) Tertiary [] (e) Adult []
8. Main occupation:
(a) Poultry farming [] (b) Civil service [] (c) Trading [] (d) Others _____
9. Years of experience in: (a) Quail Egg production _____
(b) Chicken Egg production _____
10. Duration of Production in the present area of production (Years) _____
11. Stock Size (No. of Birds) _____
12. Do you belong to any products' Association? Yes _____ No _____
If No, state reason please _____

13. Have you ever accessed credit/loan to finance your Egg farming? (a) Yes [] (b) No []

(i). If yes, how much have you accessed? ₦_____ Source of credit _____

(ii) If No, (a) Tried without success [] (b) Did not tried [] (c) Not interested in credit [] (d) Others _____

14. How many production cycles do you have per year? _____

15. Do you keep your financial records of expenses and revenue? Yes [] No []

SECTION B: PRODUCTION INFORMATION

16. Production site(s) _____

17. What do you produce? (a) Quail Egg [] (b) Chicken Egg [] (c) Both Quail and Chicken []

(d) Others (Please specify) _____

18. Why do you practice Egg Farming?

(a) For home consumption only [] (b) For Income only [] (c) For Both income and consumption [] (d) Others Specify _____

19. Place of production (Farm land): (a) Own [] (b) rented [] (c) Others _____

20. How many Employees do you have? _____

21. How much is wage rate per month (₦) (Please indicate their status e.g. Manager, Attendant) _____

22. How did you start with the birds?

(a) Day old [] (b) After brooding [] (c) At point of lay [] (d) Hatch them []

✓ Please provide unit prices of Day-old Quail ₦ _____ Chick ₦ _____

✓ Point of lay ₦ _____

23. What management system do you operate? (a) Cage [] (b) Deep litter [] (c) Both [] (d) Others (specify please) _____

24. If you keep quails, at which age (weeks) do they start laying? _____

25. If you keep layer chick at which age (weeks) do they start laying? _____
and how for long do they keep laying eggs in weeks or months? _____

26. What are your sources of Feed?

(a) Commercially processed [] (b) Self compounded [] (c) Both Commercial and Self []

27. How much is _____ Kg of Commercial feed? Layer feed ₦ _____ other ₦ _____

28. How much does it cost you in self-processing ____ kg of Layer feed ₦ ____

Other (specify) ₦ _____

29. Please provide information on the quantity of feed in kg or bags used.

QUANTITY OF FEED USED IN KG OR BAGS									
				STARTER FEED		GROWER FEED		LAYER FEED	
P E N	BREED NAME	LAYER CHICKS	MORTALI TY RATE	QTY. OF BAGS (OR KG)	NO. OF WEEKS	QTY OF BAGS (OR KG)	NO. OF WEEKS	QTY. OF BAGS	NO. OF WEEKS
	BROILER CHICKS								
1									
2									
3									
4									
5									

Any other type of feed used (Please Specify) _____ Kg _____ ₦ _____

30. Please provide information on the quantity of drug used if any.

VACCINES /ANTIBIOTICS (Administered)	PRICE (₦)	ADDITIONAL COST IF ANY (₦) (E.g. Veterinary services)

31. Please provide information on the quantity and costs of other consumable inputs
e.g. Water and electricity (₦)

- i.....
- ii.....
- iii.....

32. Please provide information on the following durable Inputs

INPUT	PURCHASE PRICE/ UNIT	QUANTITY	YEAR OF PURCHASE	PRESENT VALUE	EXPECTED LIFE SPAN
Land or Rent					
Building					
Cages					
Drinkers					
Feeders					
Warmer / Stove					
Vehicle					

33. Please estimate loss you incurred if any due to disease outbreak during production

₦ _____

34. Please provide information on the following outputs

PEN	NUMBER OF BIRDS	EGGS COLLECTED PER DAY	NUMBER OF CRATES COLLECTED/DAY	NUMBER OF BIRDS SOLD SPENT LAYER
1				
2				
3				
4				
5				
6				

Please provide information on the prices of:

A Crate of Quail Egg ₦ _____

A Crate of Chicken Egg ₦ _____

A Spent layer ₦ _____

35. What disease or parasitic conditions did you observed during production?

	DISEASES/PARASITE (Or Symptoms)	NUMBER OF OUTBREAK	MONTH OF THE YEAR	PREVENTION/CURE
1				
2				
3				
4				
5				

36. How many times did you dispose manure in a year?.....

If you sold the manure how much is Kg or Bag ₦

37. What are the constraints (problems) encountered in production of Egg? (Please tick)

- a- High cost of feed. []
- b- Non-available market. []
- c- Non-natural brooding []
- d- Inadequate information. []
- e- Diseases/pests. []

Others.....

38. What can you suggest as possible solutions? (Specify Please for the ticked problem)

- a.....
- b.....
- c.....

39. Please rate the development of quail enterprise since it started.

- (a) Reduced significantly [] (b) Increased significantly [] (c) Remained the same []
- (d) Others _____

40. How do you think quail farming business can be improved?

.....
.....

SECTION C: MARKETING INFORMATION

- 41. Which market (s) do you supply the Eggs to?
(a) _____ (c) _____
(b) _____ (d) _____
- 42. When do you normally have high demand for?
(i) Quail Egg _____
(ii) Chicken Egg _____
- 43. Where do you sell your Egg?
(a) On farm [] (b) Market [] (c) Outlets/shop [] (d) Others (specify) _____
- 44. Price of crate of egg ₦ _____
- 45. Whom do you sell your products to?
(a) Wholesalers [] (b) Retailers [] (c) Consumers [] (d) Others (Specify) _____
- 46. At what price do sell to? Wholesalers ₦ _____ Consumers ₦ _____
- 47. How do you transport your Inputs and Products?
(a) Hired vehicle [] (b) Personal vehicle [] (c) Other (specify) _____
- 48. How much did you spent on transportation per week? ₦ _____
- 49. How do you store your Eggs?
(a) On farm [] (b) At home [] (c) Not stored [] (d) Others (Specify please) _____
 ✓ Please provide your estimated cost of storage ₦ _____
- 50. How do you handle the Eggs? (a) Bag [] (b) Carton [] (c) Crates []
(d) Others _____
- 51. What are the constraints (problems) you encountered in marketing of the Eggs?
.....
.....
.....
- 52. Please suggest solutions to the identified constraints
.....
.....
- 53. How much do you spent as income tax in a year? ₦ _____

Thank you for your Cooperation

APPENDIX II: MARKETING: QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION
FACULTY OF AGRICULTURE
SCHOOL OF POSTGRADUATE STUDIES
BAYERO UNIVERSITY, KANO

POSTGRADUATE RESEARCH QUESTIONNAIRE

TOPIC: ECONOMICS OF QUAIL AND CHICKEN EGG PRODUCTION
AND MARKETING IN KANO METROPOLIS, NIGERIA.

MARKETING: QUESTIONNAIRE

INTERVIEWER (Name) _____ DATE _____

Please fill in the space or tick (√) where applicable.

MARKETER: Quail Eggs []

Chicken Eggs []

SECTION A: SOCIO-ECONOMIC INFORMATION

1. Name of Marketer _____ Phone no. _____

2. Local Government Area _____

3. Age _____

4. Gender: (a) Male [] (b) Female []

5. Marital status: (a) Single [] (b) Married [] (c) Widowed [] (d) Divorced []

6. Household size _____

7. Education level: (a) Primary [] (b) Secondary [] (c) Tertiary [] (d) Adult []

8. Main Occupation:

(a) Egg marketing [] (b) Civil Service [] (c) Trading [] (d) Others (specify) _____

9. Years of experience in marketing Quail egg _____ Chicken egg _____

10. Do you belong any products' Association? Yes _____ No _____

If No, state reason please _____

SECTION B: MARKETING INFORMATION

11. Marketing site _____

12. Which poultry egg you deal in?

(a) Quail Egg only [] (c) Chicken Egg only [] (d) Both quail and Chicken Egg []

12. Are you? (a) Wholesaler [] (b) Retailer [] (c) Both. []

14. Where do you source the products from?

(a) Farm directly [] (b) Middlemen [] (c) Self-produced [] (d) Others _____

15. Please at what price do you receive? (i) a Crate of Quail egg ₦_____

(ii) a Crate of Chicken egg ₦_____

16. Where is your point of sales?

(a) On farm/market [] (b) Market only [] (c) Outlets/shop [] (d) Others (specify)_____

17. Retail price: crate of Quail egg? ₦_____ and Chicken egg ₦_____

18. How do you transport the Egg? (a) Crate [] (b) Bag [] (c) Carton []

(d)Other_____

19. Who are your major buyers?

(a) Super markets [] (b) Hotel/Restaurants [] (c) Tea Processors [] (d) Consumers []

20. Please how many numbers you sold per week of?

(i) Crates of Quail egg _____

(ii) Chicken egg _____

21. How much do you spent on transportation per week? ₦_____

22. How do you store your product?

.....

23. Please how much does it costs you keep/store eggs in a week? ₦ _____

24. Please provide information on the following durable Inputs

INPUT	PURCHASE PRICE/ UNIT	QUANTITY	YEAR OF PURCHASE	PRESENT VALUE	EXPECTED LIFE SPAN
Land/Building/Rent					
Cages					
Drinkers					
Feeders					
Crates					
Warmer/Stove					
Vehicle					

25. Please provide information on costs consumable inputs used e.g. oil/gas and electricity (₦)

i.....

ii.....

26. What disease or parasitic conditions did you observed during Marketing?

	DISEASES/PARASITE (Symptoms)	NUMBER OF OUTBREAK	MONTH OF THE YEAR	PREVENTION/CURE
1				
2				
3				
4				

27. Please estimate loss you incurred if any due to disease outbreak during marketing

₦ _____

28. What constraints (problems) you encountered in marketing of the Eggs? (Please specify for Quail or Chicken egg).

a- Price fluctuations. []

b. Transportation []

c- Poor sales []

d. Inadequate capital []

e. Inadequate advertisement []

Others.....

29. Please suggest solutions to the identified constraints

.....
.....

30. What do you think should be done to improve upon the marketing of quail and Chicken egg?

.....
.....

31. How much do you spent as income tax in a year? ₦ _____

Thanks for your co-operation

APPENDIX III: DATA ANALYSIS

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = QSWEZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a production function

The dependent variable is logged

the ols estimates are:

coefficient	standard-error	t-ratio
beta 0	0.51195485E+00	0.26924802E+00 0.19014247E+01
beta 1	0.17242040E+00	0.12624063E+00 0.13658075E+01
beta 2	0.77111433E+00	0.11982750E+00 0.64352033E+01
beta 3	-0.20196601E+00	0.15162396E+00 -0.13320191E+01
beta 4	0.22200629E-01	0.84390550E-01 0.26307008E+00
sigma-squared	0.15943118E-01	

log likelihood function = 0.30625997E+02

the estimates after the grid search were :

beta 0	0.63600294E+00
beta 1	0.17242040E+00
beta 2	0.77111433E+00
beta 3	-0.20196601E+00
beta 4	0.22200629E-01
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00
delta 6	0.00000000E+00

sigma-squared 0.29477195E-01
gamma 0.82000000E+00
iteration = 0 func evals = 20 llf = 0.31943782E+02
0.63600294E+00 0.17242040E+00 0.77111433E+00-0.20196601E+00
0.22200629E-01
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00
0.00000000E+00 0.00000000E+00 0.29477195E-01 0.82000000E+00
gradient step
iteration = 5 func evals = 49 llf = 0.34936437E+02
0.61888262E+00 0.37831789E+00 0.55378541E+00-0.69259823E-01
0.66777057E-01
-0.35852208E-01-0.20676412E-01-0.19680851E-01 0.96901322E-03
0.15871984E+00
-0.19874771E-01 0.00000000E+00 0.25576210E-01 0.90373844E+00
iteration = 10 func evals = 73 llf = 0.39364697E+02
0.69556252E+00 0.57933967E+00 0.40416978E+00-0.91951581E-01
0.36050630E-01
-0.36540740E+00-0.14901156E+00-0.17118116E+00 0.27393623E-01
0.86913236E+00
0.14022824E+00 0.00000000E+00 0.27389574E-01 0.98221178E+00
iteration = 15 func evals = 125 llf = 0.49840024E+02
0.74261853E+00 0.68975184E+00 0.31080765E+00-0.99407422E-01
0.31425820E-01
-0.30455683E+01-0.10190205E+00 0.39335186E-01 0.12559101E+01
0.12246808E+01
0.42623941E+00 0.00000000E+00 0.50631701E-01 0.99712330E+00
iteration = 20 func evals = 157 llf = 0.50130319E+02
0.73024061E+00 0.72160170E+00 0.29511235E+00-0.84141075E-01
0.28073381E-01
-0.31924210E+01-0.77937639E-03 0.79601449E-01 0.12969306E+01
0.98613238E+00
0.43713999E+00 0.00000000E+00 0.51950815E-01 0.99795687E+00

iteration = 25 func evals = 181 llf = 0.50130811E+02
0.72998125E+00 0.72186910E+00 0.29497330E+00-0.84018238E-01
0.28082529E-01
-0.31941253E+01-0.16320131E-02 0.78583783E-01 0.13002316E+01
0.98678957E+00
0.43738190E+00 0.00000000E+00 0.51946744E-01 0.99795329E+00
iteration = 30 func evals = 202 llf = 0.50132144E+02
0.72968989E+00 0.72216944E+00 0.29481708E+00-0.83880182E-01
0.28092857E-01
-0.31968334E+01-0.25890782E-02 0.77440019E-01 0.13039382E+01
0.98752674E+00
0.43765389E+00 0.00000000E+00 0.51942174E-01 0.99794925E+00
iteration = 35 func evals = 232 llf = 0.51262342E+02
0.68729183E+00 0.80851794E+00 0.26279822E+00-0.65200256E-01
0.10649529E-01
-0.49449745E+01-0.41407840E+00-0.48195918E-01 0.26031512E+01
0.14651043E+01
0.48594479E+00 0.00000000E+00 0.58334559E-01 0.99731948E+00
iteration = 40 func evals = 295 llf = 0.53444956E+02
0.74163519E+00 0.78695532E+00 0.24295301E+00-0.54092884E-01
0.23705812E-01
-0.76952995E+01-0.97340424E+00 0.82186084E-01 0.44984071E+01
0.21114213E+01
0.59047392E+00 0.00000000E+00 0.79002712E-01 0.99949663E+00
iteration = 45 func evals = 365 llf = 0.54752861E+02
0.71846100E+00 0.82149118E+00 0.23281561E+00-0.38742943E-01
0.16503106E-01
-0.11698654E+02-0.21837680E+01 0.56992724E+00 0.73450573E+01
0.34551377E+01
0.95422007E+00 0.00000000E+00 0.11964560E+00 0.99943406E+00
iteration = 48 func evals = 382 llf = 0.54753148E+02
0.71845276E+00 0.82148813E+00 0.23281955E+00-0.38743157E-01
0.16504283E-01

-0.11699541E+02 -0.21840796E+01 0.57004292E+00 0.73457139E+01
0.34554677E+01

0.95430137E+00 0.00000000E+00 0.11965609E+00 0.99943412E+00

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.71845276E+00	0.60695162E-01	0.11837068E+02
beta 1	0.82148813E+00	0.55693610E-01	0.14750132E+02
beta 2	0.23281955E+00	0.36056914E-01	0.64570015E+01
beta 3	-0.38743157E-01	0.39938293E-01	-0.97007542E+00
beta 4	0.16504283E-01	0.14809726E-01	0.11144220E+01
delta 0	-0.11699541E+02	0.41999901E+01	-0.27856116E+01
delta 1	-0.21840796E+01	0.15511742E+01	-0.14080170E+01
delta 2	0.57004292E+00	0.10376590E+01	0.54935476E+00
delta 3	0.73457139E+01	0.31191580E+01	0.23550310E+01
delta 4	0.34554677E+01	0.14777346E+01	0.23383547E+01
delta 5	0.95430137E+00	0.39817158E+00	0.23967089E+01
delta 6	0.00000000E+00	0.10000000E+01	0.00000000E+00
sigma-squared	0.11965609E+00	0.45517334E-01	0.26288026E+01
gamma	0.99943412E+00	0.62180888E-03	0.16073011E+04

log likelihood function = 0.54753146E+02

LR test of the one-sided error = 0.48254298E+02

with number of restrictions = 8

[note that this statistic has a mixed chi-square distribution]

number of iterations = 48

(maximum number of iterations set at : 100)

number of cross-sections = 43

number of time periods = 1

total number of observations = 43

thus there are: 0 obsns not in the panel

covariance matrix :

0.36839027E-02	-0.62476905E-03	-0.61552115E-03	0.62196688E-03	-
0.20207507E-03				
0.10887259E+00	0.38233952E-01	-0.13667146E-01	-0.81154705E-01	-
0.39600902E-01				
-0.11227594E-01	0.00000000E+00	-0.12344111E-02	-0.14327839E-04	
-0.62476905E-03	0.31017782E-02	-0.16288197E-02	0.45214160E-03	-
0.47637102E-03				
-0.24192277E-01	-0.37183650E-03	0.60043626E-02	0.11823044E-01	-
0.14409390E-02				
0.30717497E-02	0.00000000E+00	0.18785840E-03	-0.90669012E-05	
-0.61552115E-03	-0.16288197E-02	0.13001011E-02	-0.47259574E-03	
0.17675222E-03				
-0.84968966E-02	-0.93655704E-02	-0.58129790E-03	0.10516632E-01	
0.10419373E-01				
0.11163251E-02	0.00000000E+00	0.22061780E-03	0.60850454E-05	
0.62196688E-03	0.45214160E-03	-0.47259574E-03	0.15950673E-02	-
0.11240558E-03				
-0.33566614E-01	-0.84440316E-02	0.15869121E-02	0.23887548E-01	
0.76837222E-02				
0.25892304E-02	0.00000000E+00	0.29245557E-03	0.32708777E-05	
-0.20207507E-03	-0.47637102E-03	0.17675222E-03	-0.11240558E-03	
0.21932798E-03				
-0.81884089E-02	-0.29826798E-02	0.64844775E-03	0.67068210E-02	
0.36648438E-02				
0.30356439E-03	0.00000000E+00	0.52228667E-04	0.54342510E-05	
0.10887259E+00	-0.24192277E-01	-0.84968966E-02	-0.33566614E-01	-
0.81884089E-02				
0.17639917E+02	0.52684243E+01	-0.20051679E+01	-0.12594200E+02	-
0.58315980E+01				
-0.13978425E+01	0.00000000E+00	-0.17833530E+00	-0.65787364E-03	
0.38233952E-01	-0.37183650E-03	-0.93655704E-02	-0.84440316E-02	-
0.29826798E-02				
0.52684243E+01	0.24061413E+01	-0.63578630E+00	-0.45048777E+01	-
0.19865899E+01				
-0.50598872E+00	0.00000000E+00	-0.58669433E-01	-0.21462779E-03	

-0.13667146E-01 0.64844775E-03	0.60043626E-02	-0.58129790E-03	0.15869121E-02
-0.20051679E+01 0.64809546E+00	-0.63578630E+00	0.10767362E+01	0.13172976E+01
0.16481854E+00	0.00000000E+00	0.21350748E-01	0.86489374E-04
-0.81154705E-01 0.67068210E-02	0.11823044E-01	0.10516632E-01	0.23887548E-01
-0.12594200E+02 0.43193407E+01	-0.45048777E+01	0.13172976E+01	0.97291469E+01
0.10517013E+01	0.00000000E+00	0.12984587E+00	0.49860899E-03
-0.39600902E-01 0.36648438E-02	-0.14409390E-02	0.10419373E-01	0.76837222E-02
-0.58315980E+01 0.21836996E+01	-0.19865899E+01	0.64809546E+00	0.43193407E+01
0.48879019E+00	0.00000000E+00	0.61763477E-01	0.24391064E-03
-0.11227594E-01 0.30356439E-03	0.30717497E-02	0.11163251E-02	0.25892304E-02
-0.13978425E+01 0.48879019E+00	-0.50598872E+00	0.16481854E+00	0.10517013E+01
0.15854061E+00	0.00000000E+00	0.15967598E-01	0.42134479E-04
0.00000000E+00 0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00 0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.10000000E+01	0.00000000E+00	0.00000000E+00
-0.12344111E-02 0.52228667E-04	0.18785840E-03	0.22061780E-03	0.29245557E-03
-0.17833530E+00 0.61763477E-01	-0.58669433E-01	0.21350748E-01	0.12984587E+00
0.15967598E-01	0.00000000E+00	0.20718277E-02	0.63671627E-05
-0.14327839E-04 0.54342510E-05	-0.90669012E-05	0.60850454E-05	0.32708777E-05
-0.65787364E-03 0.24391064E-03	-0.21462779E-03	0.86489374E-04	0.49860899E-03
0.42134479E-04	0.00000000E+00	0.63671627E-05	0.38664628E-06

technical efficiency estimates :

firm	year	eff.-est.
1	1	0.93110666E+00
2	1	0.97278111E+00
3	1	0.99375856E+00
4	1	0.92951443E+00
5	1	0.95840836E+00
6	1	0.98758910E+00
7	1	0.89741547E+00
8	1	0.79122845E+00
9	1	0.89787483E+00
10	1	0.94759365E+00
11	1	0.98001302E+00
12	1	0.72538824E+00
13	1	0.96248261E+00
14	1	0.79401150E+00
15	1	0.97242395E+00
16	1	0.93943724E+00
17	1	0.98349394E+00
18	1	0.92494216E+00
19	1	0.97416412E+00
20	1	0.91467094E+00
21	1	0.95013494E+00
22	1	0.95927177E+00
23	1	0.97225332E+00
24	1	0.99584868E+00
25	1	0.98820881E+00
26	1	0.99387954E+00
27	1	0.89676886E+00

28	1	0.85990802E+00
29	1	0.36987477E+00
30	1	0.97212771E+00
31	1	0.97528241E+00
32	1	0.94592648E+00
33	1	0.91204264E+00
34	1	0.91624228E+00
35	1	0.97093672E+00
36	1	0.98747390E+00
37	1	0.94292571E+00
38	1	0.91815151E+00
39	1	0.98803935E+00
40	1	0.81817130E+00
41	1	0.89787470E+00
42	1	0.96101520E+00
43	1	0.60880729E+00

mean efficiency = 0.91347591E+00

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = QSWAZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a cost function

The dependent variable is logged

the ols estimates are :

coefficient	standard-error	t-ratio	
beta 0	0.11484058E+01	0.25070000E+00	0.45807971E+01
beta 1	0.51437603E+00	0.15746647E+00	0.32665750E+01
beta 2	0.17116617E+00	0.14478536E+00	0.11822064E+01
beta 3	0.19834614E+00	0.53004851E-01	0.37420375E+01
beta 4	0.11308261E-01	0.47798021E-01	0.23658429E+00
sigma-squared	0.23356859E-02		

log likelihood function = 0.71921512E+02

the estimates after the grid search were :

beta 0	0.11401680E+01
beta 1	0.51437603E+00
beta 2	0.17116617E+00
beta 3	0.19834614E+00
beta 4	0.11308261E-01
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00

delta 6 0.00000000E+00
 sigma-squared 0.21319569E-02
 gamma 0.50000000E-01
 iteration = 0 func evals = 20 llf = 0.71889685E+02
 0.11401680E+01 0.51437603E+00 0.17116617E+00 0.19834614E+00
 0.11308261E-01
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.21319569E-02 0.50000000E-01
 gradient step
 iteration = 5 func evals = 51 llf = 0.72609292E+02
 0.11371469E+01 0.51737228E+00 0.17743181E+00 0.18654205E+00
 0.14174306E-01
 0.28819856E-02-0.54383900E-02 0.57506716E-02-0.16841726E-01
 0.12805124E-01
 0.48725051E-01 0.00000000E+00 0.20158076E-02 0.45123841E-01
 iteration = 10 func evals = 72 llf = 0.72969824E+02
 0.10771206E+01 0.46597774E+00 0.21854916E+00 0.19601015E+00
 0.22924140E-01
 0.66182389E-01 0.17849908E+00 0.70601405E-01-0.25433231E+00-
 0.22369099E-01
 0.46149612E-01 0.00000000E+00 0.20785079E-02 0.12295259E+00
 iteration = 15 func evals = 110 llf = 0.73331942E+02
 0.11428423E+01 0.48104164E+00 0.21314971E+00 0.17215620E+00
 0.24411053E-01
 0.60239596E-01 0.22966539E+00 0.59198711E-01-0.29960521E+00-
 0.50128360E-02
 0.36131368E-01 0.00000000E+00 0.19718352E-02 0.94054591E-02
 pt better than entering pt cannot be found
 iteration = 20 func evals = 137 llf = 0.73432121E+02
 0.11427789E+01 0.48111007E+00 0.21320919E+00 0.17213417E+00
 0.23816048E-01

0.61445723E-01 0.22824754E+00 0.61612059E-01-0.29986491E+00-
0.51530525E-02

0.36130202E-01 0.00000000E+00 0.19721138E-02 0.77305123E-02

the final mle estimates are :

coefficient standard-error t-ratio

beta 0 0.11427789E+01 0.23834926E+00 0.47945561E+01

beta 1 0.48111007E+00 0.82658214E-01 0.58204750E+01

beta 2 0.21320919E+00 0.65982462E-01 0.32313009E+01

beta 3 0.17213417E+00 0.12013439E-01 0.14328467E+02

beta 4 0.23816048E-01 0.21816043E+00 0.10916759E+00

delta 0 0.61445723E-01 0.19592429E+01 0.31361973E-01

delta 1 0.22824754E+00 0.10562664E+01 0.21608899E+00

delta 2 0.61612059E-01 0.29577495E+01 0.20830723E-01

delta 3 -0.29986491E+00 0.38652834E+00 -0.77579023E+00

delta 4 -0.51530525E-02 0.69330225E+00 -0.74326205E-02

delta 5 0.36130202E-01 0.91831969E-01 0.39343817E+00

delta 6 0.00000000E+00 0.10000000E+01 0.00000000E+00

sigma-squared 0.19721138E-02 0.38456086E-03 0.51282229E+01

gamma 0.77305123E-02 0.97717700E+00 0.79110666E-02

log likelihood function = 0.73432121E+02

LR test of the one-sided error = 0.30212190E+01

with number of restrictions = 8

[note that this statistic has a mixed chi-square distribution]

number of iterations = 20

(maximum number of iterations set at : 100)

number of cross-sections = 43

number of time periods = 1

total number of observations = 43

thus there are: 0 obsns not in the panel

covariance matrix :

0.56810370E-01	0.25258404E-01	0.10264064E-01	-0.16072234E-01	-
0.46900115E-01				
-0.39420510E+00	-0.14646916E+00	0.45759042E+00	0.30956551E+00	
0.92739549E-01				
0.91267393E-02	0.00000000E+00	0.61164727E-04	-0.11324529E+00	
0.25258404E-01	0.68323803E-02	-0.60590729E-01	0.99408511E-02	
0.64524610E-01				
0.49841232E+00	0.18369921E+00	-0.55407478E+00	-0.39663000E+00	-
0.11445573E+00				
-0.15842891E-01	0.00000000E+00	-0.91252228E-04	0.16215770E+00	
0.10264064E-01	-0.60590729E-01	0.43536853E-02	0.85669407E-02	
0.64490087E-01				
0.51903446E+00	0.26769860E+00	-0.60715090E+00	-0.48619154E+00	-
0.13677236E+00				
-0.21538782E-01	0.00000000E+00	-0.12578675E-03	0.17807654E+00	
-0.16072234E-01	0.99408511E-02	0.85669407E-02	0.14432272E-03	-
0.22391540E-01				
-0.14848189E+00	-0.72358825E-01	0.16869562E+00	0.13537547E+00	
0.37290048E-01				
0.63712065E-02	0.00000000E+00	0.36749471E-04	-0.50320248E-01	
-0.46900115E-01	0.64524610E-01	0.64490087E-01	-0.22391540E-01	
0.47593974E-01				
-0.12510056E+01	-0.49600034E+00	0.13350338E+01	0.74053675E+00	
0.27844915E+00				
0.46206969E-01	0.00000000E+00	0.25420084E-03	-0.28588806E+00	
-0.39420510E+00	0.49841232E+00	0.51903446E+00	-0.14848189E+00	-
0.12510056E+01				
0.38386329E+01	-0.56054703E+01	0.76445741E+01	0.22042365E+01	
0.19499382E+01				
0.32687160E+00	0.00000000E+00	0.18626098E-02	-0.29276515E+01	
-0.14646916E+00	0.18369921E+00	0.26769860E+00	-0.72358825E-01	-
0.49600034E+00				
-0.56054703E+01	0.11156987E+01	0.37657266E+01	0.14146754E+01	
0.89024861E+00				
0.12436298E+00	0.00000000E+00	0.77747205E-03	-0.13441831E+01	

0.45759042E+00 0.13350338E+01	-0.55407478E+00	-0.60715090E+00	0.16869562E+00	
0.76445741E+01 0.24018776E+01	0.37657266E+01	0.87482820E+01	-0.10219962E+02	-
-0.37710868E+00	0.00000000E+00	-0.20984456E-02	0.30958439E+01	
0.30956551E+00 0.74053675E+00	-0.39663000E+00	-0.48619154E+00	0.13537547E+00	
0.22042365E+01 0.19406761E+01	0.14146754E+01	-0.10219962E+02	0.14940416E+00	-
-0.27523903E+00	0.00000000E+00	-0.15634085E-02	0.22644083E+01	
0.92739549E-01 0.27844915E+00	-0.11445573E+00	-0.13677236E+00	0.37290048E-01	
0.19499382E+01 0.48066801E+00	0.89024861E+00	-0.24018776E+01	-0.19406761E+01	
-0.78400081E-01	0.00000000E+00	-0.45328382E-03	0.69200501E+00	
0.91267393E-02 0.46206969E-01	-0.15842891E-01	-0.21538782E-01	0.63712065E-02	
0.32687160E+00 0.78400081E-01	0.12436298E+00	-0.37710868E+00	-0.27523903E+00	-
0.84331106E-02	0.00000000E+00	-0.67529577E-04	0.10451119E+00	
0.00000000E+00 0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	
0.00000000E+00 0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	
0.00000000E+00	0.10000000E+01	0.00000000E+00	0.00000000E+00	
0.61164727E-04 0.25420084E-03	-0.91252228E-04	-0.12578675E-03	0.36749471E-04	
0.18626098E-02 0.45328382E-03	0.77747205E-03	-0.20984456E-02	-0.15634085E-02	-
-0.67529577E-04	0.00000000E+00	0.14788705E-06	0.59597520E-03	
-0.11324529E+00 0.28588806E+00	0.16215770E+00	0.17807654E+00	-0.50320248E-01	-
-0.29276515E+01 0.69200501E+00	-0.13441831E+01	0.30958439E+01	0.22644083E+01	
0.10451119E+00	0.00000000E+00	0.59597520E-03	0.95487489E+0	

cost efficiency estimates :

firm	year	eff.-est.
1	1	0.10281873E+01
2	1	0.10251227E+01
3	1	0.10399928E+01
4	1	0.10182360E+01
5	1	0.10097997E+01
6	1	0.10399729E+01
7	1	0.10009175E+01
8	1	0.10091777E+01
9	1	0.10127710E+01
10	1	0.10034335E+01
11	1	0.10219101E+01
12	1	0.10031845E+01
13	1	0.10150346E+01
14	1	0.10014599E+01
15	1	0.10013561E+01
16	1	0.10118866E+01
17	1	0.10004667E+01
18	1	0.10118095E+01
19	1	0.10022819E+01
20	1	0.10287838E+01
21	1	0.10006976E+01
22	1	0.10005487E+01
23	1	0.10454316E+01
24	1	0.10225994E+01
25	1	0.10010206E+01
26	1	0.10638584E+01
27	1	0.10018471E+01

28	1	0.10064954E+01
29	1	0.10462407E+01
30	1	0.10405138E+01
31	1	0.10270040E+01
32	1	0.10106624E+01
33	1	0.10138059E+01
34	1	0.10387788E+01
35	1	0.10201876E+01
36	1	0.10393372E+01
37	1	0.10008752E+01
38	1	0.10031347E+01
39	1	0.10390020E+01
40	1	0.10007302E+01
41	1	0.10165644E+01
42	1	0.10449252E+01
43	1	0.10174259E+01

mean efficiency = 0.10183133E+01

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = QMWEZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a production function

The dependent variable is logged

the ols estimates are:

coefficient	standard-error	t-ratio
beta 0	0.14062387E+01	0.17109469E+02 0.82190666E-01
beta 1	0.72500324E+00	0.11181832E+02 0.64837609E-01
beta 2	-0.18541717E+00	0.41599216E+00 -0.44572275E+00
beta 3	0.46999166E-01	0.22515260E+00 0.20874360E+00
beta 4	0.21895254E+00	0.11164528E+02 0.19611445E-01
sigma-squared	0.47989622E-01	

log likelihood function = 0.61782729E+01

the estimates after the grid search were :

beta 0	0.16102456E+01
beta 1	0.72500324E+00
beta 2	-0.18541717E+00
beta 3	0.46999166E-01
beta 4	0.21895254E+00
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00

delta 6 0.00000000E+00
 sigma-squared 0.82752796E-01
 gamma 0.79000000E+00
 iteration = 0 func evals = 20 llf = 0.91802386E+01
 0.16102456E+01 0.72500324E+00-0.18541717E+00 0.46999166E-01
 0.21895254E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.82752796E-01 0.79000000E+00
 gradient step
 iteration = 5 func evals = 44 llf = 0.12204875E+02
 0.14585540E+01 0.84518405E+00-0.12829603E+00 0.14761560E+00
 0.10617793E+00
 0.17476453E-01-0.42646769E-01 0.17061969E-01 0.29654262E-02
 0.77019228E-01
 -0.23643791E+00 0.00000000E+00 0.68706663E-01 0.79924417E+00
 iteration = 10 func evals = 61 llf = 0.16246223E+02
 0.14577585E+01 0.73694010E+00 0.28724759E-01 0.14944484E+00
 0.51346162E-01
 -0.46970907E+00 0.47061826E+00 0.11911642E+00-0.66835595E+00
 0.19410648E+01
 -0.10894456E+01 0.00000000E+00 0.95899247E-01 0.85832068E+00
 iteration = 15 func evals = 103 llf = 0.16830039E+02
 0.14049598E+01 0.73901235E+00 0.90671770E-01 0.14652297E+00
 0.12561706E-01
 -0.65740262E+00 0.59855613E+00 0.15318447E+00-0.83363072E+00
 0.24032926E+01
 -0.12877415E+01 0.00000000E+00 0.10413020E+00 0.88779812E+00
 iteration = 20 func evals = 157 llf = 0.17186069E+02
 0.13101159E+01 0.78584633E+00 0.52142336E-01 0.13044935E+00
 0.39425334E-01
 -0.79646050E+00 0.67124329E+00 0.32796971E+00-0.87967841E+00
 0.24258308E+01

-0.14771407E+01 0.00000000E+00 0.12297503E+00 0.92090691E+00

iteration = 25 func evals = 225 llf = 0.17605212E+02

0.11007989E+01 0.65800627E+00-0.23537393E-01 0.11725824E+00
0.22976522E+00

-0.70860987E+00 0.83784294E+00 0.18432838E+01-0.11865776E+01
0.15781727E+01

-0.22347339E+01 0.00000000E+00 0.18052735E+00 0.94175143E+00

iteration = 30 func evals = 280 llf = 0.17832727E+02

0.10330287E+01 0.64791814E+00 0.30346385E-02 0.11292088E+00
0.23164260E+00

-0.69165179E+00 0.88436047E+00 0.21204864E+01-0.13093112E+01
0.16231963E+01

-0.22798669E+01 0.00000000E+00 0.18817138E+00 0.94264802E+00

iteration = 34 func evals = 295 llf = 0.17832762E+02

0.10330078E+01 0.64789421E+00 0.30354613E-02 0.11292209E+00
0.23166213E+00

-0.69163909E+00 0.88439218E+00 0.21206643E+01-0.13093756E+01
0.16231581E+01

-0.22799454E+01 0.00000000E+00 0.18817847E+00 0.94265138E+00

the final mle estimates are :

coefficient	standard-error	t-ratio
beta 0	0.10330078E+01	0.81134661E+00 0.12732016E+01
beta 1	0.64789421E+00	0.57212622E+00 0.11324323E+01
beta 2	0.30354613E-02	0.20367118E+00 0.14903735E-01
beta 3	0.11292209E+00	0.15057598E+00 0.74993428E+00
beta 4	0.23166213E+00	0.55911127E+00 0.41433995E+00
delta 0	-0.69163909E+00	0.92715503E+00 -0.74597998E+00
delta 1	0.88439218E+00	0.86847016E+00 0.10183334E+01
delta 2	0.21206643E+01	0.26420795E+01 0.80264971E+00
delta 3	-0.13093756E+01	0.11097295E+01 -0.11799051E+01
delta 4	0.16231581E+01	0.10251528E+01 0.15833328E+01
delta 5	-0.22799454E+01	0.11199081E+01 -0.20358326E+01

delta 6 0.00000000E+00 0.10000000E+01 0.00000000E+00
 sigma-squared 0.18817847E+00 0.91723550E-01 0.20515830E+01
 gamma 0.94265138E+00 0.39764572E-01 0.23705810E+02
 log likelihood function = 0.17832761E+02
 LR test of the one-sided error = 0.23308977E+02
 with number of restrictions = 8
 [note that this statistic has a mixed chi-square distribution]
 number of iterations = 34
 (maximum number of iterations set at : 100)
 number of cross-sections = 35
 number of time periods = 1
 total number of observations = 35
 thus there are: 0 obsns not in the panel
 covariance matrix :
 0.65828333E+00 0.42314784E+00 0.10745132E-01 0.79544995E-02 -
 0.43431723E+00
 -0.50305213E-01 -0.11766917E+00 -0.79382884E+00 0.24552794E+00
 0.24164830E+00
 0.33033896E+00 0.00000000E+00 -0.29150488E-01 -0.12296491E-01
 0.42314784E+00 0.32732841E+00 -0.13410742E-01 -0.13325134E-01 -
 0.29754847E+00
 -0.65740963E-01 -0.95824499E-01 -0.64823851E+00 0.21336413E+00
 0.18563324E+00
 0.27269827E+00 0.00000000E+00 -0.23607239E-01 -0.84729802E-02
 0.10745132E-01 -0.13410742E-01 0.41481950E-01 0.23089920E-02 -
 0.26272241E-01
 -0.13485077E-01 -0.11229085E-01 -0.80991129E-01 0.13485345E-01
 0.77977200E-01
 0.48167322E-01 0.00000000E+00 -0.25221203E-02 -0.11160209E-02
 0.79544995E-02 -0.13325134E-01 0.23089920E-02 0.22673125E-01
 0.33692133E-02
 0.58383849E-02 0.16479819E-02 -0.10802577E-01 -0.21697030E-02
 0.53224569E-02

0.12810675E-04 0.00000000E+00 -0.25838266E-03 -0.34278450E-04
 -0.43431723E+00 -0.29754847E+00 -0.26272241E-01 0.33692133E-02
 0.31260541E+00
 0.64270733E-01 0.97696468E-01 0.66481782E+00 -0.20496677E+00 -
 0.23524853E+00
 -0.28926305E+00 0.00000000E+00 0.23914894E-01 0.91788999E-02
 -0.50305213E-01 -0.65740963E-01 -0.13485077E-01 0.58383849E-02
 0.64270733E-01
 0.85961644E+00 -0.18300751E+00 0.41145688E+00 -0.38810158E+00 -
 0.18589855E+00
 -0.14563022E+00 0.00000000E+00 0.15476112E-01 0.50673408E-02
 -0.11766917E+00 -0.95824499E-01 -0.11229085E-01 0.16479819E-02
 0.97696468E-01
 -0.18300751E+00 0.75424042E+00 0.81612295E+00 -0.69766690E+00 -
 0.25082004E+00
 -0.57482617E+00 0.00000000E+00 0.34475779E-01 0.14281948E-01
 -0.79382884E+00 -0.64823851E+00 -0.80991129E-01 -0.10802577E-01
 0.66481782E+00
 0.41145688E+00 0.81612295E+00 0.69805841E+01 -0.19642185E+01 -
 0.18578787E+01
 -0.25011145E+01 0.00000000E+00 0.21877994E+00 0.85743651E-01
 0.24552794E+00 0.21336413E+00 0.13485345E-01 -0.21697030E-02 -
 0.20496677E+00
 -0.38810158E+00 -0.69766690E+00 -0.19642185E+01 0.12314996E+01
 0.40278645E+00
 0.85579141E+00 0.00000000E+00 -0.71249580E-01 -0.29852209E-01
 0.24164830E+00 0.18563324E+00 0.77977200E-01 0.53224569E-02 -
 0.23524853E+00
 -0.18589855E+00 -0.25082004E+00 -0.18578787E+01 0.40278645E+00
 0.10509383E+01
 0.94447377E+00 0.00000000E+00 -0.63959393E-01 -0.19963179E-01
 0.33033896E+00 0.27269827E+00 0.48167322E-01 0.12810675E-04 -
 0.28926305E+00
 -0.14563022E+00 -0.57482617E+00 -0.25011145E+01 0.85579141E+00
 0.94447377E+00

0.12541941E+01 0.00000000E+00 -0.94912015E-01 -0.36608677E-01
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.10000000E+01 0.00000000E+00 0.00000000E+00
 -0.29150488E-01 -0.23607239E-01 -0.25221203E-02 -0.25838266E-03
 0.23914894E-01
 0.15476112E-01 0.34475779E-01 0.21877994E+00 -0.71249580E-01 -
 0.63959393E-01
 -0.94912015E-01 0.00000000E+00 0.84132096E-02 0.34173377E-02
 -0.12296491E-01 -0.84729802E-02 -0.11160209E-02 -0.34278450E-04
 0.91788999E-02
 0.50673408E-02 0.14281948E-01 0.85743651E-01 -0.29852209E-01 -
 0.19963179E-01
 -0.36608677E-01 0.00000000E+00 0.34173377E-02 0.15812212E-02

technical efficiency estimates:

firm	year	eff.-est.
1	1	0.90496368E+00
2	1	0.93336166E+00
3	1	0.93934843E+00
4	1	0.92284587E+00
5	1	0.87438577E+00
6	1	0.92983794E+00
7	1	0.92145131E+00
8	1	0.87083295E+00
9	1	0.86537008E+00
10	1	0.90765591E+00
11	1	0.94428443E+00
12	1	0.94134279E+00
13	1	0.34904943E+00
14	1	0.88537679E+00

15	1	0.89488557E+00
16	1	0.91837519E+00
17	1	0.89882345E+00
18	1	0.85954513E+00
19	1	0.87115388E+00
20	1	0.95984479E+00
21	1	0.93337519E+00
22	1	0.91537174E+00
23	1	0.91372820E+00
24	1	0.94617396E+00
25	1	0.95101597E+00
26	1	0.94855280E+00
27	1	0.95375104E+00
28	1	0.94183551E+00
29	1	0.93595472E+00
30	1	0.94764169E+00
31	1	0.96824825E+00
32	1	0.97993111E+00
33	1	0.94490313E+00
34	1	0.89675421E+00
35	1	0.88786051E+00

mean efficiency = 0.90450952E+00

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = QMWAZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a cost function

The dependent variable is logged

the ols estimates are:

coefficient	standard-error	t-ratio
beta 0	0.41448102E+00	0.54897659E+00 0.75500672E+00
beta 1	-0.36557387E-02	0.70965355E-01 -0.51514414E-01
beta 2	0.91853372E+00	0.36254813E+00 0.25335497E+01
beta 3	-0.28642574E-02	0.82404484E-01 -0.34758514E-01
beta 4	0.56120056E-01	0.36341392E+00 0.15442462E+00
sigma-squared	0.95131557E-02	

log likelihood function = 0.34498683E+02

the estimates after the grid search were :

beta 0	0.39810763E+00
beta 1	-0.36557387E-02
beta 2	0.91853372E+00
beta 3	-0.28642574E-02
beta 4	0.56120056E-01
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00
delta 6	0.00000000E+00

sigma-squared 0.84222211E-02
 gamma 0.50000000E-01
 iteration = 0 func evals = 20 llf = 0.34465650E+02
 0.39810763E+00-0.36557387E-02 0.91853372E+00-0.28642574E-02
 0.56120056E-01
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.84222211E-02 0.50000000E-01
 gradient step
 iteration = 5 func evals = 44 llf = 0.35050209E+02
 0.39877357E+00-0.50556819E-02 0.91785158E+00-0.17389350E-02
 0.54812460E-01
 0.90414086E-02-0.41156832E-02-0.75527357E-02 0.13605251E-02
 0.54001434E-01
 0.22450504E-02 0.00000000E+00 0.81058139E-02 0.52622645E-01
 iteration = 10 func evals = 63 llf = 0.35206585E+02
 0.40333448E+00 0.41823527E-02 0.93677825E+00-0.31871303E-01
 0.42623516E-01
 0.70620140E-01-0.25347472E-01-0.64217470E-01-0.10900550E-01
 0.10221805E+00
 0.33938868E-01 0.00000000E+00 0.86318880E-02 0.21770184E+00
 iteration = 15 func evals = 136 llf = 0.36638069E+02
 0.46868508E+00 0.18613361E-01 0.95198080E+00-0.43428115E-01
 0.10217102E-01
 0.17896775E+00 0.10677648E-01-0.73870834E-01-0.13519512E+00
 0.12301227E+00
 0.40666812E-01 0.00000000E+00 0.75553332E-02 0.29631676E-02
 iteration = 20 func evals = 177 llf = 0.38820213E+02
 0.27927579E+00 0.21283810E-01 0.11803552E+01-0.59819925E-01-
 0.21978414E+00
 0.13291468E+00-0.43756709E-01-0.17591145E+00-0.98485662E-01
 0.14412234E+00
 0.81611738E-01 0.00000000E+00 0.64497383E-02 0.27391869E-02

iteration = 25 func evals = 205 llf = 0.39629038E+02

0.10385023E+00 0.22779191E-01 0.12980098E+01-0.59139577E-01-
0.33407369E+00

0.29202699E+00-0.61024265E-01-0.32252116E+00-0.16692527E+00
0.17585412E+00

0.75393918E-01 0.00000000E+00 0.63268081E-02 0.30865006E-02

iteration = 30 func evals = 241 llf = 0.39710873E+02

0.95320622E-01 0.21731542E-01 0.13146401E+01-0.67112003E-01-
0.34354683E+00

0.30085637E+00-0.60418866E-01-0.33655477E+00-0.17158513E+00
0.17846879E+00

0.74247394E-01 0.00000000E+00 0.62274187E-02 0.31143901E-02

pt better than entering pt cannot be found

iteration = 31 func evals = 249 llf = 0.39710873E+02

0.95320622E-01 0.21731542E-01 0.13146401E+01-0.67112003E-01-
0.34354683E+00

0.30085637E+00-0.60418866E-01-0.33655477E+00-0.17158513E+00
0.17846879E+00

0.74247394E-01 0.00000000E+00 0.62274187E-02 0.31143901E-02

the final mle estimates are :

coefficient standard-error t-ratio

beta 0 0.95320622E-01 0.55584975E+00 0.17148631E+00

beta 1 0.21731542E-01 0.64658304E-01 0.33609824E+00

beta 2 0.13146401E+01 0.40484340E+00 0.32472805E+01

beta 3 -0.67112003E-01 0.82538554E-01 -0.81309884E+00

beta 4 -0.34354683E+00 0.40264351E+00 -0.85322829E+00

delta 0 0.30085637E+00 0.32218017E+00 0.93381408E+00

delta 1 -0.60418866E-01 0.13604090E+00 -0.44412282E+00

delta 2 -0.33655477E+00 0.23781218E+00 -0.14152125E+01

delta 3 -0.17158513E+00 0.21184389E+00 -0.80996027E+00

delta 4 0.17846879E+00 0.83148344E-01 0.21463902E+01

delta 5 0.74247394E-01 0.61285894E-01 0.12114924E+01

delta 6 0.00000000E+00 0.10000000E+01 0.00000000E+00
 sigma-squared 0.62274187E-02 0.16927487E-02 0.36788797E+01
 gamma 0.31143901E-02 0.46822142E-03 0.66515327E+01
 log likelihood function = 0.39710873E+02
 LR test of the one-sided error = 0.10424380E+02
 with number of restrictions = 8
 [note that this statistic has a mixed chi-square distribution]
 number of iterations = 31
 (maximum number of iterations set at : 100)
 number of cross-sections = 35
 number of time periods = 1
 total number of observations = 35
 thus there are: 0 obsns not in the panel
 covariance matrix :
 0.30896895E+00 -0.11931158E-02 -0.19574357E+00 -0.16716869E-03
 0.18500083E+00
 -0.31151057E-01 0.14637165E-01 0.56030301E-02 0.85657304E-02
 0.24548593E-02
 -0.94997414E-02 0.00000000E+00 0.47800870E-04 -0.50868246E-04
 -0.11931158E-02 0.41806963E-02 0.52894307E-02 -0.25957324E-02 -
 0.86714313E-02
 0.61922862E-02 -0.91977434E-03 -0.37781177E-02 -0.23703403E-02 -
 0.11673999E-03
 0.51536200E-03 0.00000000E+00 -0.69749633E-05 0.16472420E-05
 -0.19574357E+00 0.52894307E-02 0.16389818E+00 -0.13296001E-01 -
 0.16012441E+00
 0.23154125E-01 -0.13416731E-01 -0.69959281E-02 -0.49085421E-02 -
 0.50284845E-03
 0.10382655E-01 0.00000000E+00 -0.69717043E-05 0.31583440E-04
 -0.16716869E-03 -0.25957324E-02 -0.13296001E-01 0.68126129E-02
 0.12961357E-01
 -0.84818012E-02 0.19820807E-02 0.60964977E-02 0.27040853E-02
 0.18146607E-03

-0.15922855E-02 0.00000000E+00 -0.14194165E-05 -0.37697325E-06
 0.18500083E+00 -0.86714313E-02 -0.16012441E+00 0.12961357E-01
 0.16212180E+00
 -0.20661051E-01 0.13056409E-01 0.53673000E-02 0.40830818E-02 -
 0.71076676E-04
 -0.10274657E-01 0.00000000E+00 0.63699310E-05 -0.31278072E-04
 -0.31151057E-01 0.61922862E-02 0.23154125E-01 -0.84818012E-02 -
 0.20661051E-01
 0.10380006E+00 -0.15246867E-02 -0.36251174E-01 -0.53889231E-01 -
 0.12322749E-01
 0.25968671E-02 0.00000000E+00 -0.42359084E-05 0.47666033E-05
 0.14637165E-01 -0.91977434E-03 -0.13416731E-01 0.19820807E-02
 0.13056409E-01
 -0.15246867E-02 0.18507125E-01 -0.31763396E-02 -0.15702127E-01
 0.74882217E-03
 -0.59599341E-02 0.00000000E+00 0.18816255E-04 -0.78294496E-05
 0.56030301E-02 -0.37781177E-02 -0.69959281E-02 0.60964977E-02
 0.53673000E-02
 -0.36251174E-01 -0.31763396E-02 0.56554632E-01 0.15386517E-01
 0.40359008E-02
 -0.16292854E-02 0.00000000E+00 0.89865232E-05 -0.18475466E-04
 0.85657304E-02 -0.23703403E-02 -0.49085421E-02 0.27040853E-02
 0.40830818E-02
 -0.53889231E-01 -0.15702127E-01 0.15386517E-01 0.44877834E-01
 0.41806746E-02
 0.32682456E-02 0.00000000E+00 -0.38015332E-05 0.27118044E-05
 0.24548593E-02 -0.11673999E-03 -0.50284845E-03 0.18146607E-03 -
 0.71076676E-04
 -0.12322749E-01 0.74882217E-03 0.40359008E-02 0.41806746E-02
 0.69136471E-02
 -0.31166224E-04 0.00000000E+00 -0.17942091E-04 0.10612255E-04
 -0.94997414E-02 0.51536200E-03 0.10382655E-01 -0.15922855E-02 -
 0.10274657E-01
 0.25968671E-02 -0.59599341E-02 -0.16292854E-02 0.32682456E-02 -
 0.31166224E-04

0.37559608E-02 0.00000000E+00 -0.15759794E-04 0.35945772E-05
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.10000000E+01 0.00000000E+00 0.00000000E+00
 0.47800870E-04 -0.69749633E-05 -0.69717043E-05 -0.14194165E-05
 0.63699310E-05
 -0.42359084E-05 0.18816255E-04 0.89865232E-05 -0.38015332E-05 -
 0.17942091E-04
 -0.15759794E-04 0.00000000E+00 0.28653981E-05 0.22398599E-08
 -0.50868246E-04 0.16472420E-05 0.31583440E-04 -0.37697325E-06 -
 0.31278072E-04
 0.47666033E-05 -0.78294496E-05 -0.18475466E-04 0.27118044E-05
 0.10612255E-04
 0.35945772E-05 0.00000000E+00 0.22398599E-08 0.21923130E-06

cost efficiency estimates :

firm	year	eff.-est.
1	1	0.10407005E+01
2	1	0.10006802E+01
3	1	0.10014870E+01
4	1	0.10179985E+01
5	1	0.10296434E+01
6	1	0.10005597E+01
7	1	0.10318004E+01
8	1	0.10006246E+01
9	1	0.10000000E+01
10	1	0.10005306E+01
11	1	0.10000000E+01
12	1	0.10005222E+01
13	1	0.10005282E+01
14	1	0.10000000E+01

15	1	0.10006451E+01
16	1	0.10000000E+01
17	1	0.10000000E+01
18	1	0.10360947E+01
19	1	0.10000000E+01
20	1	0.11108172E+01
21	1	0.10017382E+01
22	1	0.10048477E+01
23	1	0.10005952E+01
24	1	0.10142516E+01
25	1	0.10000000E+01
26	1	0.10016961E+01
27	1	0.10058103E+01
28	1	0.10022644E+01
29	1	0.10000000E+01
30	1	0.10000000E+01
31	1	0.10000000E+01
32	1	0.10000000E+01
33	1	0.10020526E+01
34	1	0.10000000E+01
35	1	0.10012578E+01

mean efficiency = 0.10087756E+01

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = CSWEZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a production function

The dependent variable is logged

the ols estimates are :

coefficient	standard-error	t-ratio	
beta 0	0.13248430E+01	0.89724475E+00	0.14765681E+01
beta 1	0.65828501E+00	0.85683829E+00	0.76827217E+00
beta 2	-0.50031914E+00	0.67558521E+00	-0.74057148E+00
beta 3	-0.22012482E+00	0.30647853E+00	-0.71823894E+00
beta 4	0.74125519E+00	0.21435031E+00	0.34581485E+01
sigma-squared	0.75489524E-01		

log likelihood function = -0.28057861E+01

the estimates after the grid search were :

beta 0	0.13716758E+01
beta 1	0.65828501E+00
beta 2	-0.50031914E+00
beta 3	-0.22012482E+00
beta 4	0.74125519E+00
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00
delta 6	0.00000000E+00

sigma-squared 0.68904987E-01
 gamma 0.50000000E-01
 iteration = 0 func evals = 20 llf = -0.28731738E+01
 0.13716758E+01 0.65828501E+00-0.50031914E+00-0.22012482E+00
 0.74125519E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.68904987E-01 0.50000000E-01

gradient step

iteration = 5 func evals = 64 llf = -0.27433944E+01
 0.13646618E+01 0.66925306E+00-0.48150961E+00-0.22010713E+00
 0.71841656E+00
 0.11280287E-01 0.85558837E-03 0.00000000E+00-0.19247460E-02-
 0.36133214E-01
 0.16284109E-01-0.20781713E-01 0.63883125E-01 0.11042067E-07

the final mle estimates are:

coefficient	standard-error	t-ratio
beta 0	0.13646618E+01	0.98244323E+00
beta 1	0.66925306E+00	0.90198143E+00
beta 2	-0.48150961E+00	0.91554168E+00
beta 3	-0.22010713E+00	0.99990781E+00
beta 4	0.71841656E+00	0.59658843E+00
delta 0	0.11280287E-01	0.93863215E+00
delta 1	0.85558837E-03	0.78794759E+00
delta 2	0.00000000E+00	0.10000000E+01
delta 3	-0.19247460E-02	0.81803821E+00
delta 4	-0.36133214E-01	0.95443530E+00
delta 5	0.16284109E-01	0.98420036E+00
delta 6	-0.20781713E-01	0.99367050E+00
sigma-squared	0.63883125E-01	0.18918796E-01
gamma	0.11042067E-07	0.12211563E-02

log likelihood function = -0.27433944E+01

LR test of the one-sided error = 0.12478339E+00

with number of restrictions = 8

[note that this statistic has a mixed chi-square distribution]

number of iterations = 5

(maximum number of iterations set at: 100)

number of cross-sections = 43

number of time periods = 1

total number of observations = 43

thus there are: 0 obsns not in the panel

covariance matrix:

0.96519470E+00	-0.75603718E-01	-0.66727132E-01	-0.21497955E-02	-
0.14935643E+00				
0.12941927E-01	0.21237303E-01	0.00000000E+00	0.19531904E-01	
0.72787396E-02				
0.77281754E-02	0.15761818E-02	-0.12231899E-02	0.38327361E-04	
-0.75603718E-01	0.81357050E+00	-0.17236226E+00	-0.57414034E-02	-
0.33281432E+00				
-0.22296666E-01	-0.44274075E-01	0.00000000E+00	-0.42085540E-01	-
0.28680896E-01				
-0.88410573E-02	-0.13493317E-01	0.24996663E-02	-0.14164581E-03	
-0.66727132E-01	-0.17236226E+00	0.83821657E+00	-0.54447792E-02	-
0.29669193E+00				
-0.37433854E-01	-0.70918242E-01	0.00000000E+00	-0.66911027E-01	-
0.40983719E-01				
-0.16829884E-01	-0.17867334E-01	0.40591457E-02	-0.21327583E-03	
-0.21497955E-02	-0.57414034E-02	-0.54447792E-02	0.99981563E+00	-
0.96293942E-02				
-0.16248122E-02	-0.30328458E-02	0.00000000E+00	-0.28545614E-02	-
0.16827488E-02				
-0.75678070E-03	-0.71235874E-03	0.19465322E-03	-0.31806937E-05	
-0.14935643E+00	-0.33281432E+00	-0.29669193E+00	-0.96293942E-02	
0.35591775E+00				

0.36530019E-01 0.57056900E-01 0.00000000E+00 0.51961372E-01
 0.14483540E-01
 0.23494683E-01 0.39814602E-03 -0.33076001E-02 0.17388755E-03
 0.12941927E-01 -0.22296666E-01 -0.37433854E-01 -0.16248122E-02
 0.36530019E-01
 0.88103032E+00 -0.21236784E+00 0.00000000E+00 -0.19836627E+00 -
 0.10286645E+00
 -0.61052790E-01 -0.38555651E-01 -0.33141748E-02 0.48843456E-04
 0.21237303E-01 -0.44274075E-01 -0.70918242E-01 -0.30328458E-02
 0.57056900E-01
 -0.21236784E+00 0.62086140E+00 0.00000000E+00 -0.35415171E+00 -
 0.18370224E+00
 -0.10895236E+00 -0.68903503E-01 -0.16503473E-02 0.51648235E-04
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.10000000E+01 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.19531904E-01 -0.42085540E-01 -0.66911027E-01 -0.28545614E-02
 0.51961372E-01
 -0.19836627E+00 -0.35415171E+00 0.00000000E+00 0.66918652E+00 -
 0.17160803E+00
 -0.10176305E+00 -0.64376046E-01 -0.79490101E-03 0.48056667E-04
 0.72787396E-02 -0.28680896E-01 -0.40983719E-01 -0.16827488E-02
 0.14483540E-01
 -0.10286645E+00 -0.18370224E+00 0.00000000E+00 -0.17160803E+00
 0.91094674E+00
 -0.52738237E-01 -0.33472230E-01 0.53135149E-02 -0.10592286E-03
 0.77281754E-02 -0.88410573E-02 -0.16829884E-01 -0.75678070E-03
 0.23494683E-01
 -0.61052790E-01 -0.10895236E+00 0.00000000E+00 -0.10176305E+00 -
 0.52738237E-01
 0.96865034E+00 -0.19737889E-01 -0.38793693E-02 0.82188372E-04
 0.15761818E-02 -0.13493317E-01 -0.17867334E-01 -0.71235874E-03
 0.39814602E-03

-0.38555651E-01 -0.68903503E-01 0.00000000E+00 -0.64376046E-01 -
 0.33472230E-01
 -0.19737889E-01 0.98738107E+00 0.48212100E-02 -0.53460780E-04
 -0.12231899E-02 0.24996663E-02 0.40591457E-02 0.19465322E-03 -
 0.33076001E-02
 -0.33141748E-02 -0.16503473E-02 0.00000000E+00 -0.79490101E-03
 0.53135149E-02
 -0.38793693E-02 0.48212100E-02 0.35792084E-03 -0.33033203E-05
 0.38327361E-04 -0.14164581E-03 -0.21327583E-03 -0.31806937E-05
 0.17388755E-03
 0.48843456E-04 0.51648235E-04 0.00000000E+00 0.48056667E-04 -
 0.10592286E-03
 0.82188372E-04 -0.53460780E-04 -0.33033203E-05 0.14912227E-05

technical efficiency estimates:

firm	year	eff.-est.
1	1	0.10000000E+01
2	1	0.10000000E+01
3	1	0.10000000E+01
4	1	0.10000000E+01
5	1	0.10000000E+01
6	1	0.99774593E+00
7	1	0.10000000E+01
8	1	0.10000000E+01
9	1	0.10000000E+01
10	1	0.10000000E+01
11	1	0.10000000E+01
12	1	0.10000000E+01
13	1	0.99608467E+00
14	1	0.99492996E+00
15	1	0.98992207E+00
16	1	0.10000000E+01

17	1	0.10000000E+01
18	1	0.99324180E+00
19	1	0.10000000E+01
20	1	0.10000000E+01
21	1	0.10000000E+01
22	1	0.99961368E+00
23	1	0.10000000E+01
24	1	0.10000000E+01
25	1	0.99474567E+00
26	1	0.10000000E+01
27	1	0.99587068E+00
28	1	0.10000000E+01
29	1	0.10000000E+01
30	1	0.99804371E+00
31	1	0.10000000E+01
32	1	0.99992801E+00
33	1	0.99254982E+00
34	1	0.99974031E+00
35	1	0.99750537E+00
36	1	0.99926722E+00
37	1	0.99752828E+00
38	1	0.10000000E+01
39	1	0.10000000E+01
40	1	0.99750105E+00
41	1	0.10000000E+01
42	1	0.99398816E+00
43	1	0.99741950E+00

mean efficiency = 0.99850293E+00

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = CSWAZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a cost function

The dependent variable is logged

the ols estimates are:

	coefficient	standard-error	t-ratio
beta 0	0.13477476E+01	0.15685829E+07	0.85921352E-06
beta 1	0.15720707E-01	0.22615748E+00	0.69512214E-01
beta 2	0.38712828E+00	0.11727091E+01	0.33011450E+00
beta 3	0.46223895E+00	0.56461392E+06	0.81868146E-06
beta 4	0.35166236E+00	0.12377668E+01	0.28411036E+00
sigma-squared	0.13370150E+00		

log likelihood function = -0.15095525E+02

the estimates after the grid search were:

beta 0	0.92252830E+00
beta 1	0.15720707E-01
beta 2	0.38712828E+00
beta 3	0.46223895E+00
beta 4	0.35166236E+00
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00
delta 6	0.00000000E+00
sigma-squared	0.29896626E+00

```

gamma      0.95000000E+00
iteration =  0 func evals =  20 llf = 0.25679857E+01
  0.92252830E+00  0.15720707E-01  0.38712828E+00  0.46223895E+00
0.35166236E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00
  0.00000000E+00 0.00000000E+00 0.29896626E+00 0.95000000E+00
gradient step
iteration =  5 func evals =  51 llf = 0.58733891E+02
  0.92260068E+00  0.18246569E-01  0.38861931E+00  0.46244002E+00
0.35257337E+00
 -0.13905552E+00-0.22469498E+00          0.00000000E+00-0.20598624E+00-
0.72934973E-01
 -0.82552389E-01-0.13743999E-01 0.18780564E+00 0.99668582E+00
iteration = 10 func evals =  82 llf = 0.65389105E+02
  0.90651917E+00-0.87027447E-01  0.51110196E+00  0.41776316E+00
0.32770798E+00
 -0.22151084E+00-0.33002548E+00          0.00000000E+00-0.29537307E+00-
0.11640288E+00
 -0.93278647E-01-0.17372689E-01 0.21987895E+00 0.99988342E+00
iteration = 15 func evals = 110 llf = 0.67735092E+02
  0.91170205E+00-0.10101077E+00  0.50350049E+00  0.43216199E+00
0.34272191E+00
 -0.23762074E+00-0.33975615E+00          0.00000000E+00-0.29975317E+00-
0.12872279E+00
 -0.80847236E-01-0.12993560E-01 0.21729485E+00 0.99996784E+00
iteration = 20 func evals = 138 llf = 0.67949010E+02
  0.91199397E+00-0.10192087E+00  0.50363525E+00  0.43297297E+00
0.34281295E+00
 -0.23842358E+00-0.33995376E+00          0.00000000E+00-0.29954834E+00-
0.12992253E+00
 -0.80052876E-01-0.12016239E-01 0.21691504E+00 0.99997630E+00
pt better than entering pt cannot be found

```

iteration = 24 func evals = 167 llf = 0.68821864E+02

0.91276263E+00-0.10424588E+00 0.50453129E+00 0.43510844E+00
0.34283919E+00

-0.24045081E+00-0.34022597E+00 0.00000000E+00-0.29867827E+00-
0.13349261E+00

-0.77973918E-01-0.88245615E-02 0.21565738E+00 0.99999999E+00

the final mle estimates are :

coefficient standard-error t-ratio

beta 0 0.91276263E+00 0.94068659E+00 0.97031534E+00

beta 1 -0.10424588E+00 0.35269001E-01 -0.29557366E+01

beta 2 0.50453129E+00 0.27608787E-01 0.18274301E+02

beta 3 0.43510844E+00 0.33403060E+00 0.13026005E+01

beta 4 0.34283919E+00 0.46103127E-01 0.74363543E+01

delta 0 -0.24045081E+00 0.91730285E+00 -0.26212805E+00

delta 1 -0.34022597E+00 0.77327210E+00 -0.43998222E+00

delta 2 0.00000000E+00 0.10000000E+01 0.00000000E+00

delta 3 -0.29867827E+00 0.81370388E+00 -0.36706016E+00

delta 4 -0.13349261E+00 0.97868095E+00 -0.13640054E+00

delta 5 -0.77973918E-01 0.96626973E+00 -0.80695810E-01

delta 6 -0.88245615E-02 0.99757922E+00 -0.88459757E-02

sigma-squared 0.21565738E+00 0.21526661E-01 0.10018153E+02

gamma 0.99999999E+00 0.40815266E-03 0.24500636E+04

log likelihood function = 0.68821864E+02

LR test of the one-sided error = 0.16783478E+03

with number of restrictions = 8

[note that this statistic has a mixed chi-square distribution]

number of iterations = 24

(maximum number of iterations set at : 100)

number of cross-sections = 43

number of time periods = 1

total number of observations = 43

thus there are: 0 obsns not in the panel

covariance matrix :

0.88489126E+00	0.26418166E-02	0.22395097E-02	-0.31978949E+00	-
0.36764103E-02				
0.15744377E-02	0.12873897E-02	0.00000000E+00	0.11758574E-02	-
0.17414041E-03				
-0.19874902E-02	0.17980650E-02	-0.14049849E-02	-0.75151185E-05	
0.26418166E-02	0.12439024E-02	-0.11807094E-01	0.73393660E-02	
0.10139379E-01				
-0.71489714E-02	-0.59439316E-02	0.00000000E+00	-0.46719409E-02	-
0.41806830E-04				
0.54578367E-02	-0.45648870E-02	0.45327019E-02	0.76252613E-05	
0.22395097E-02	-0.11807094E-01	0.76224512E-03	0.62216968E-02	
0.55554465E-02				
-0.53197270E-02	-0.26317338E-02	0.00000000E+00	-0.11056962E-02	-
0.35450856E-02				
0.64238141E-02	0.40083966E-03	0.32460718E-02	0.62081233E-04	
-0.31978949E+00	0.73393660E-02	0.62216968E-02	0.11157644E+00	-
0.10213624E-01				
0.43740262E-02	0.35765634E-02	0.00000000E+00	0.32667096E-02	-
0.48378840E-03				
-0.55215483E-02	0.49952964E-02	-0.39032606E-02	-0.20878136E-04	
-0.36764103E-02	0.10139379E-01	0.55554465E-02	-0.10213624E-01	
0.21254984E-02				
0.74151129E-02	0.30169257E-02	0.00000000E+00	0.74353852E-03	
0.35787212E-02				
-0.93143867E-02	-0.96690129E-04	-0.75960559E-02	-0.71019317E-04	
0.15744377E-02	-0.71489714E-02	-0.53197270E-02	0.43740262E-02	
0.74151129E-02				
0.84144453E+00	-0.25010285E+00	0.00000000E+00	-0.22842321E+00	-
0.80522204E-01				
-0.83342821E-01	-0.19255906E-01	0.20218845E-02	0.28345443E-04	
0.12873897E-02	-0.59439316E-02	-0.26317338E-02	0.35765634E-02	
0.30169257E-02				

-0.25010285E+00 0.59794973E+00 0.00000000E+00 -0.36844959E+00 -
 0.12937526E+00
 -0.14437941E+00 -0.27076122E-01 0.32103827E-04 0.36333514E-04
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.10000000E+01 0.00000000E+00
 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.11758574E-02 -0.46719409E-02 -0.11056962E-02 0.32667096E-02
 0.74353852E-03
 -0.22842321E+00 -0.36844959E+00 0.00000000E+00 0.66211400E+00 -
 0.11847879E+00
 -0.13390818E+00 -0.24329804E-01 -0.51842513E-03 0.37577276E-04
 -0.17414041E-03 -0.41806830E-04 -0.35450856E-02 -0.48378840E-03
 0.35787212E-02
 -0.80522204E-01 -0.12937526E+00 0.00000000E+00 -0.11847879E+00
 0.95781640E+00
 -0.46549637E-01 -0.80661373E-02 -0.75163990E-04 -0.24082589E-04
 -0.19874902E-02 0.54578367E-02 0.64238141E-02 -0.55215483E-02 -
 0.93143867E-02
 -0.83342821E-01 -0.14437941E+00 0.00000000E+00 -0.13390818E+00 -
 0.46549637E-01
 0.93367720E+00 -0.39852097E-02 -0.41528357E-02 -0.15504001E-04
 0.17980650E-02 -0.45648870E-02 0.40083966E-03 0.49952964E-02 -
 0.96690129E-04
 -0.19255906E-01 -0.27076122E-01 0.00000000E+00 -0.24329804E-01 -
 0.80661373E-02
 -0.39852097E-02 0.99516429E+00 0.14691348E-02 0.52606565E-04
 -0.14049849E-02 0.45327019E-02 0.32460718E-02 -0.39032606E-02 -
 0.75960559E-02
 0.20218845E-02 0.32103827E-04 0.00000000E+00 -0.51842513E-03 -
 0.75163990E-04
 -0.41528357E-02 0.14691348E-02 0.46339711E-03 -0.24773865E-04
 -0.75151185E-05 0.76252613E-05 0.62081233E-04 -0.20878136E-04 -
 0.71019317E-04

0.28345443E-04 0.36333514E-04 0.00000000E+00 0.37577276E-04 -
0.24082589E-04

-0.15504001E-04 0.52606565E-04 -0.24773865E-04 0.16658859E-06

cost efficiency estimates :

firm	year	eff.-est.
1	1	0.10659986E+01
2	1	0.10659759E+01
3	1	0.10205205E+01
4	1	0.10015611E+01
5	1	0.10170741E+01
6	1	0.10677800E+01
7	1	0.10682652E+01
8	1	0.10737367E+01
9	1	0.10307398E+01
10	1	0.10640190E+01
11	1	0.10253827E+01
12	1	0.11001444E+01
13	1	0.10659808E+01
14	1	0.10457229E+01
15	1	0.10402696E+01
16	1	0.10030928E+01
17	1	0.10601278E+01
18	1	0.10405114E+01
19	1	0.10554550E+01
20	1	0.10387095E+01
21	1	0.10443482E+01
22	1	0.10253827E+01
23	1	0.10369898E+01
24	1	0.10548725E+01
25	1	0.10415811E+01

26	1	0.12238925E+01
27	1	0.10003823E+01
28	1	0.10389480E+01
29	1	0.10504094E+01
30	1	0.10695673E+01
31	1	0.10636813E+01
32	1	0.10354249E+01
33	1	0.10041245E+01
34	1	0.10680175E+01
35	1	0.12314739E+01
36	1	0.10564748E+01
37	1	0.10441407E+01
38	1	0.10221827E+01
39	1	0.10019552E+01
40	1	0.10660999E+01
41	1	0.10113537E+01
42	1	0.10660007E+01
43	1	0.10737367E+01

mean efficiency = 0.10530723E+01

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = CMWEZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a production function

The dependent variable is logged

the ols estimates are:

coefficient	standard-error	t-ratio
beta 0	0.60141377E+00	0.84953611E-02 0.70793197E+02
beta 1	0.27010144E-02	0.11951320E-02 0.22600134E+01
beta 2	-0.30153803E-02	0.77369230E-03 -0.38973896E+01
beta 3	0.24822116E-02	0.12037569E-02 0.20620540E+01
beta 4	0.10027256E+01	0.19187117E-02 0.52260357E+03
sigma-squared	0.14356365E-05	

log likelihood function = 0.18847808E+03

the estimates after the grid search were :

beta 0	0.60250153E+00
beta 1	0.27010144E-02
beta 2	-0.30153803E-02
beta 3	0.24822116E-02
beta 4	0.10027256E+01
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00
delta 6	0.00000000E+00
sigma-squared	0.24137680E-05

gamma 0.77000000E+00
iteration = 0 func evals = 20 llf = 0.19022079E+03
0.60250153E+00 0.27010144E-02 -0.30153803E-02 0.24822116E-02
0.10027256E+01
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00
0.00000000E+00 0.00000000E+00 0.24137680E-05 0.77000000E+00

gradient step

pt better than entering pt cannot be found

iteration = 1 func evals = 28 llf = 0.19022079E+03
0.60250153E+00 0.27010144E-02 -0.30153803E-02 0.24822116E-02
0.10027256E+01
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00
0.00000000E+00 0.00000000E+00 0.24137680E-05 0.77000000E+00

the final mle estimates are :

coefficient	standard-error	t-ratio
beta 0	0.60250153E+00	0.10000000E+01
beta 1	0.27010144E-02	0.10000000E+01
beta 2	-0.30153803E-02	0.10000000E+01
beta 3	0.24822116E-02	0.10000000E+01
beta 4	0.10027256E+01	0.10000000E+01
delta 0	0.00000000E+00	0.10000000E+01
delta 1	0.00000000E+00	0.10000000E+01
delta 2	0.00000000E+00	0.10000000E+01
delta 3	0.00000000E+00	0.10000000E+01
delta 4	0.00000000E+00	0.10000000E+01
delta 5	0.00000000E+00	0.10000000E+01
delta 6	0.00000000E+00	0.10000000E+01
sigma-squared	0.24137680E-05	0.10000000E+01
gamma	0.77000000E+00	0.10000000E+01

log likelihood function = 0.19022079E+03

LR test of the one-sided error = 0.34854144E+01

with number of restrictions = 8

[note that this statistic has a mixed chi-square distribution]

number of iterations = 1

(maximum number of iterations set at : 100)

number of cross-sections = 35

number of time periods = 1

total number of observations = 35

thus there are: 0 obsns not in the panel

covariance matrix :

0.10000000E+01	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.10000000E+01	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.10000000E+01	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.10000000E+01
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00

0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00			
0.00000000E+00	0.10000000E+01	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.10000000E+01	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.10000000E+01

technical efficiency estimates :

firm	year	eff.-est.
1	1	0.99869408E+00
2	1	0.99923430E+00
3	1	0.99931317E+00
4	1	0.99876775E+00
5	1	0.99910908E+00
6	1	0.99938899E+00
7	1	0.99931592E+00
8	1	0.99942153E+00
9	1	0.99889546E+00
10	1	0.99927553E+00
11	1	0.99865685E+00
12	1	0.99888174E+00
13	1	0.99875915E+00
14	1	0.99923147E+00
15	1	0.99924836E+00

16	1	0.99947199E+00
17	1	0.99927927E+00
18	1	0.99927114E+00
19	1	0.99849083E+00
20	1	0.99825455E+00
21	1	0.99911847E+00
22	1	0.99918124E+00
23	1	0.99925564E+00
24	1	0.99868431E+00
25	1	0.99881411E+00
26	1	0.99852220E+00
27	1	0.99879063E+00
28	1	0.99918962E+00
29	1	0.99924169E+00
30	1	0.99904903E+00
31	1	0.99857540E+00
32	1	0.99839900E+00
33	1	0.99562539E+00
34	1	0.99969036E+00
35	1	0.99972117E+00

mean efficiency = 0.99893770E+00

Output from the program FRONTIER (Version 4.1c)

instruction file = terminal

data file = CMWAZ.txt

Tech. Eff. Effects Frontier (see B&C 1993)

The model is a cost function

The dependent variable is logged

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.22718896E+01	0.31381792E+07	-0.72395150E-06
beta 1	-0.16866392E+00	0.11443089E+02	-0.14739370E-01
beta 2	0.66807301E+00	0.88407140E+01	0.75567766E-01
beta 3	0.42978318E+00	0.59714872E+06	0.71972554E-06
beta 4	0.53072766E+00	0.11775615E+02	0.45070058E-01
sigma-squared	0.49201488E+00		

log likelihood function = -0.34553400E+02

the estimates after the grid search were :

beta 0	-0.23896407E+01
beta 1	-0.16866392E+00
beta 2	0.66807301E+00
beta 3	0.42978318E+00
beta 4	0.53072766E+00
delta 0	0.00000000E+00
delta 1	0.00000000E+00
delta 2	0.00000000E+00
delta 3	0.00000000E+00
delta 4	0.00000000E+00
delta 5	0.00000000E+00
delta 6	0.00000000E+00
sigma-squared	0.43559238E+00

gamma 0.50000000E-01
iteration = 0 func evals = 20 llf = -0.34583721E+02
-0.23896407E+01-0.16866392E+00 0.66807301E+00 0.42978318E+00
0.53072766E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00
0.00000000E+00 0.00000000E+00 0.43559238E+00 0.50000000E-01

gradient step

pt better than entering pt cannot be found

iteration = 3 func evals = 41 llf = 0.68123143E+01
-0.23818195E+01-0.12978121E+00 0.71818042E+00 0.47088573E+00
0.56584696E+00
-0.11819708E-01-0.20235029E-01-0.35580866E-02-0.18526162E-01-
0.64640606E-02
-0.10269792E-01-0.78381713E-03 0.42655627E-01 0.17133462E+00

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.23818195E+01	0.99578758E+00	-0.23918952E+01
beta 1	-0.12978121E+00	0.88371152E+00	-0.14685925E+00
beta 2	0.71818042E+00	0.79975808E+00	0.89799708E+00
beta 3	0.47088573E+00	0.87624986E+00	0.53738751E+00
beta 4	0.56584696E+00	0.90581648E+00	0.62468168E+00
delta 0	-0.11819708E-01	0.98104010E+00	-0.12048139E-01
delta 1	-0.20235029E-01	0.94277218E+00	-0.21463329E-01
delta 2	-0.35580866E-02	0.99829671E+00	-0.35641574E-02
delta 3	-0.18526162E-01	0.95163931E+00	-0.19467630E-01
delta 4	-0.64640606E-02	0.99435301E+00	-0.65007704E-02
delta 5	-0.10269792E-01	0.98705726E+00	-0.10404454E-01
delta 6	-0.78381713E-03	0.99995448E+00	-0.78385281E-03
sigma-squared	0.42655627E-01	0.85321613E+00	0.49993929E-01
gamma	0.17133462E+00	0.75581202E+00	0.22668946E+00

log likelihood function = 0.68123143E+01

LR test of the one-sided error = 0.82731429E+02

with number of restrictions = 8

[note that this statistic has a mixed chi-square distribution]

number of iterations = 3

(maximum number of iterations set at : 100)

number of cross-sections = 35

number of time periods = 1

total number of observations = 35

thus there are: 0 obsns not in the panel

covariance matrix :

0.99159291E+00	-0.42910647E-01	-0.55040818E-01	-0.44181569E-01	-
0.38842925E-01				
-0.72250876E-03	-0.12292178E-02	-0.21749681E-03	-0.11249025E-02	-
0.39093830E-03				
-0.60791316E-03	-0.42648384E-04	-0.46493325E-03	0.65505060E-03	
-0.42910647E-01	0.78094604E+00	-0.28096943E+00	-0.22550714E+00	-
0.19829115E+00				
-0.25621172E-02	-0.43373786E-02	-0.77127413E-03	-0.39572206E-02	-
0.13790027E-02				
-0.21714164E-02	-0.16227673E-03	0.69881346E-03	0.71457582E-02	
-0.55040818E-01	-0.28096943E+00	0.63961298E+00	-0.28925450E+00	-
0.25433747E+00				
-0.35423545E-02	-0.60038805E-02	-0.10663550E-02	-0.54816304E-02	-
0.19089892E-02				
-0.29970467E-02	-0.22074869E-03	0.19785482E-03	0.83011044E-02	
-0.44181569E-01	-0.22550714E+00	-0.28925450E+00	0.76781382E+00	-
0.20413015E+00				
-0.37969804E-02	-0.64598744E-02	-0.11430050E-02	-0.59116694E-02	-
0.20544873E-02				
-0.31947493E-02	-0.22412888E-03	-0.24433509E-02	0.34424694E-02	
-0.38842925E-01	-0.19829115E+00	-0.25433747E+00	-0.20413015E+00	
0.82050350E+00				

-0.22375096E-02 -0.37855968E-02 -0.67355752E-03 -0.34525326E-02 -
 0.12035249E-02
 -0.18979465E-02 -0.14287078E-03 0.85564028E-03 0.67444441E-02
 -0.72250876E-03 -0.25621172E-02 -0.35423545E-02 -0.37969804E-02 -
 0.22375096E-02
 0.96243967E+00 -0.64621821E-01 -0.11306785E-01 -0.59540242E-01 -
 0.20567156E-01
 -0.31080137E-01 -0.18490357E-02 -0.10181715E+00 -0.12686343E+00
 -0.12292178E-02 -0.43373786E-02 -0.60038805E-02 -0.64598744E-02 -
 0.37855968E-02
 -0.64621821E-01 0.88881938E+00 -0.19453107E-01 -0.10243787E+00 -
 0.35385404E-01
 -0.53472763E-01 -0.31812194E-02 -0.17517826E+00 -0.21827058E+00
 -0.21749681E-03 -0.77127413E-03 -0.10663550E-02 -0.11430050E-02 -
 0.67355752E-03
 -0.11306785E-01 -0.19453107E-01 0.99659632E+00 -0.17923399E-01 -
 0.61913309E-02
 -0.93560535E-02 -0.55661521E-03 -0.30650018E-01 -0.38189698E-01
 -0.11249025E-02 -0.39572206E-02 -0.54816304E-02 -0.59116694E-02 -
 0.34525326E-02
 -0.59540242E-01 -0.10243787E+00 -0.17923399E-01 0.90561738E+00 -
 0.32602854E-01
 -0.49267890E-01 -0.29310566E-02 -0.16140584E+00 -0.20110888E+00
 -0.39093830E-03 -0.13790027E-02 -0.19089892E-02 -0.20544873E-02 -
 0.12035249E-02
 -0.20567156E-01 -0.35385404E-01 -0.61913309E-02 -0.32602854E-01
 0.98873790E+00
 -0.17018750E-01 -0.10124848E-02 -0.55753674E-01 -0.69469107E-01
 -0.60791316E-03 -0.21714164E-02 -0.29970467E-02 -0.31947493E-02 -
 0.18979465E-02
 -0.31080137E-01 -0.53472763E-01 -0.93560535E-02 -0.49267890E-01 -
 0.17018750E-01
 0.97428204E+00 -0.15300312E-02 -0.84243208E-01 -0.10497498E+00
 -0.42648384E-04 -0.16227673E-03 -0.22074869E-03 -0.22412888E-03 -
 0.14287078E-03

-0.18490357E-02 -0.31812194E-02 -0.55661521E-03 -0.29310566E-02 -
 0.10124848E-02
 -0.15300312E-02 0.99990897E+00 -0.50085724E-02 -0.62438018E-02
 -0.46493325E-03 0.69881346E-03 0.19785482E-03 -0.24433509E-02
 0.85564028E-03
 -0.10181715E+00 -0.17517826E+00 -0.30650018E-01 -0.16140584E+00 -
 0.55753674E-01
 -0.84243208E-01 -0.50085724E-02 0.72797776E+00 -0.34638728E+00
 0.65505060E-03 0.71457582E-02 0.83011044E-02 0.34424694E-02
 0.67444441E-02
 -0.12686343E+00 -0.21827058E+00 -0.38189698E-01 -0.20110888E+00 -
 0.69469107E-01
 -0.10497498E+00 -0.62438018E-02 -0.34638728E+00 0.57125181E+00

cost efficiency estimates:

firm	year	eff.-est.
1	1	0.10369889E+01
2	1	0.10367031E+01
3	1	0.10371542E+01
4	1	0.10375238E+01
5	1	0.10387752E+01
6	1	0.10382290E+01
7	1	0.10394496E+01
8	1	0.10401982E+01
9	1	0.10374822E+01
10	1	0.10383063E+01
11	1	0.10372586E+01
12	1	0.10375136E+01
13	1	0.10365316E+01
14	1	0.10381389E+01
15	1	0.10386349E+01
16	1	0.10378950E+01

17	1	0.10407729E+01
18	1	0.10407532E+01
19	1	0.10377713E+01
20	1	0.10379863E+01
21	1	0.10380224E+01
22	1	0.10378059E+01
23	1	0.10372099E+01
24	1	0.10375576E+01
25	1	0.10376683E+01
26	1	0.10498767E+01
27	1	0.10376067E+01
28	1	0.10370358E+01
29	1	0.10380740E+01
30	1	0.10391022E+01
31	1	0.10377935E+01
32	1	0.10373342E+01
33	1	0.10400537E+01
34	1	0.10361983E+01
35	1	0.10360164E+01

mean efficiency = 0.10383263E+01