Measuring Elasticity of Substitution: Poultry Broiler Sector of Bangladesh

MD. MAHMUDUL HASSAN
BANGLADESH UNIVERSITY OF BUSINESS AND TECHNOLOGY

Corresponding Author:
Md. Mahmudul Hassan, Ph.D
Associate Professor, Department of Economics, Bangladesh University of Business and Technology (BUBT),77-78, Campus-2, 77-78,Rupnagar r/a, Road No. 9, Dhaka 1216, Bangladesh,

Contact No. +8801912211369
E-mail: mhsnju@gmail.com

Keywords: Constant Elasticity of substitution, Bangladesh, Factor substitution, Bangladesh Poultry

JEL Classification: O12, Q50, D23, Q16

Abstract: The present paper is mainly concerned with finding the employment potential in different sizesof poultry broiler farmsi.e. small, medium and large farms in Bangladesh. This study makes the first attempt to estimate the Constant Elasticity of Substitution (CES) model for Bangladesh poultry production. Estimated results of CES suggests that the value of elasticity of substitution between labor and farm capital machineries is comparatively high in case of broiler medium and very particularly of large farms which indicate that there is great potential for employment in large broiler farms provided there are no factor price distortions. And small farms exhibits lower substitution value. The weak elasticity of substitution value suggests that production is not easy to have the substitutability between its inputs. In this regard, there occurs urgency of doing something for the small farms from the govt. at a large scale.

The article is part of my Ph.D thesis work done in Jahangirnagar University, Savar, Dhaka, Bangladesh, under the guidance of Professor Dr. khondokar Mustahidur Rahman.

I. INTRODUCTION

An important purpose of thestudy of production function is to analyze the range to which factor substitution is possible in the organization of any production process and it is obvious that across firms or industries substitutability may vary. The current study is concerned with the empirical estimation of factor substitutiongrounded on the Constant Elasticity of Substitution (CES).Arrow et al. (1961) introduced the CES production function having the advantage to be a generalization of three key functions namely: the Leontief function (in case of perfect complements), the linear function (in case of perfect substitutes), and the Cobb-Douglas function, which assume respectively an infinite, a zero and a unit elasticity of substitution (ES) between production factors.

In a growing developing country like Bangladesh, the growth rate in capital input is well over the growth rate in labour input, and for this reason, diminishing returns to capital input may pretense a challenge to the sustainability of growth. How solemn this trouble will turn out to be, depends crucially on the elasticity of substitution between capital and labour. If the elasticity of substitution between capital and labour is high, it may be easier to sustain a relatively high rate of economic growth. This makes the elasticity of substitution between capital and labour vital to study.

The elasticity of capital labour substitution is a crucial parameter in measuring the welfare effects of policy shocks (Balestreri et al., 2003).The likelihood of efficient capital-labour substitution is vital for the achievement of most fiscal, financial and technological policies that are intended to surge employment in developing countries through the implementation of labour-intensive techniques of production (Battese and Malik, 1986). The elasticity of substitution is relevant to a number of other problems as well, in both developed and developing countries (Morawetz, 1976). If the possibilities occur for efficient capital-labour substitution, then labour can be substituted for capital without unavoidably resulting in deterioration in output. This issue remarkably relies on whether the elasticity of substitution is positive. If the possibilities exist for efficient capital-labour substitution, then labour can be substituted for capital without necessarily resulting in a decline in output (Battese and Malik, 1986). This issue remarkably relies on whether the elasticity of substitution is positive. A higher elasticity of substitution between labor and capital may result in a higher level of labor productivity in steady-state (Klump and De La Grandville, 2000).

Numerous classes of production functions are offered in the economic literature(for details see Walter, 1963, 1968; Hildebrand and Liu, 1965; Nerlove, 1967; and Ferguson, 1969) but for empirical estimates of the elasticity ofsubstitution the most extensively used production functions are the Cobb-Douglas (CD), and the Constant Elasticity of Substitution (CES).

The Cobb-Douglas tactic has often been criticized for its inflexibility. Motivated by strong empirical proof that the substitution between capital and labour is often not equal to unity in US manufacturing firms, Arrow, Chenery, Minhas, and Solow (1961) offered the constant elasticity of substitution (CES) function, where capital and labour can be substituted at a constant rate but at a value other than unity (the elasticity of substitution can take any value from zero to infinity). The CES function made a major advance in factor substitution study by allowing factor substitution of different magnitudes (0 to + ∞).

We know in Cobb-Douglas production function, elasticity of substitution is unity everywhere. But here we are discussing a production function, which has a constant elasticity of substitution (not necessary equal to unity).

The constant elasticity of substitution (CES) production function is an enhancement over the Cobb-Douglas production function as long as it recognizes the possibility of varying degrees of substitutability between capital and labor in different types of production. Such a function assumes that the basic measure of the degree of substitution (i.e. the elasticity of substitution) is constant but is no longer restricted to any prior value. Needless to say, the Cobb- Douglas and Leontief production functions are special cases of the CES manipulation. Despite the significance of estimating the CES models in poultry production, there are as yet no studies on this topic.

The present paper attempts to hit this gap. Estimating broiler CES production function has an important motivation. An estimate of constant elasticity of substitution (which is not present in current literature) for broiler meat production is necessary tocontribute to Bangladesh livestock development policy in designing appropriate policies in meat production toimprove its effectiveness towards a sustainable development.Given the fact that Bangladesh is faced with different challenges as far as the livestock subsector is concerned, it then becomes crucial to measure the elasticity of substitution. It is an important determinant of sustainability of growth rate as well as movements in factor income shares over time. Besides, in generating employment it has important implication. If elasticity of substitution is high, it indicates high employment

elasticity of production. If elasticity of substitution is low, it indicates low employment elasticity of production. In addition to this, differences in elasticity of substitution between different sectors may be related with the difference in the growth rates of these sectors. For example an industry with high elasticity of substitution usually will have a higher output rate compared to an industry with low elasticity of substitution.

The above discussion has brought out clearly the significance of the capital-labour substitution elasticity. Thus estimating CES function would help us the way taking care of the poultry broiler industry. Besides, if weakness or strengthens varies across different categories of farms i.e. small, medium and large broiler farms respectively.

Nevertheless, this issue has received no attention in the literature of agriculture economy in Bangladesh. As discussed in the coming section, there has been no study of elasticity of substitution between capital and labour for poultry industry in Bangladesh. In the absence of any work the present paper may shed some light in this regard which makes the paper special.

II. LITERATURE REVIEW

The first application of flexible form to the agricultural sector was made by H. P. Binswanger (Binswanger, 1973). He found both substitutability and complementarity relationship among different inputs and found clear evidence of biased technical change in the US agriculture. In the econometric analysis of factor substitution, *R. S.* Brown (Brown, 1978) found capital-labour and labour-material pairs to be substitutes while capital and material were found to be complements in the US agriculture. Wyzan (1981) used the translog production functions to the Soviet agricultural sector. Wyzan found substitution possibilities between land and labour. Kazi et al. (1976) estimated CES function while G. E. Battese and S. J. Malik (Battese and Malik, 1988) estimated both the CES and VES function to determine the elasticity of substituion between labour and capital for different manufacturing industries in Pakistan.

Earlier, some attempts have been made to estimate the elasticity ofsubstitution between capital and labour in Bangladesh. For instance, Raihana Bilkis (Bilkis, 2012) estimated factor substitution and technical change in Bangladesh agricultural sector for the first two decades after independence by using the trans log cost function. The elasticity estimates (0.76) were statistically significant at the 5 per cent level.

It's true that a good number of studies have been undertaken on different aspects of poultry and poultry farm in Bangladesh. The studies include production performance of poultry and demand for poultry (Ukil, 1994; Islam K.M. Nabiul, 2001, Khan et. al., 2006, Rahman et al., 2009, Shah et al, 2011), measuring relative costs, returns and economic analyses (Miah, 1990, Ahmed et al., 1985, Bhuiyan, 2003; Alam, 2004), benefit and profitability analysis of contract farming (Begum I. A. et al., 2000,Bairagi, 2004 and Jabbar et. al., 2007), effectiveness of trained farmers (Ershad et al., 2004), marketing and value chain analysis (USAID-ATDP, 2005), role of NGO in poultry (Ahmed, 2001, Shamsuddoha M., 2009), role of poultry in biogas and electricity generation (Zaman, 2007, Sajib et. al., 2015), environmental impact of the poultry sector in Bangladesh (Akter et al. 2004) etc.

There have been some studies that have examined the efficiency of agricultural production in Bangladesh based on stochastic frontier (SFA) and data envelopment analysis (DEA) (Wadud and White, 2000, Kamruzzaman et al, 2006, Haider et al. 2011, Uddin et al., 2017) aiming on major food crops like rice, wheat, fish, maize etc. and no studies have dealt with the poultry.Hassan Md. M., (Hassan, 2018) analyzed the technical efficiency of poultry broiler production in Bangladesh from a sample of 100 poultry farmers selected from Savar and Dhamrai Upazilla under Dhaka and Bajitpur and Kuliarchar Upazilla under Kishorganje district using stochastic parametric technique.

However no effort has yet been made to take into account the elasticity of substitution for poultry industries in Bangladesh.The present study tries to tackle the issue. The current work differs from previous studies in Bangladesh by introducing the concept of elasticity of substitution i.e. constant elasticity of substitution in case of poultry industry. In this study, the elasticity of substitution for small, medium and large poultry broiler farms was estimated separately. In order to avoid difficulties in time-series data cross-section analysis was made.

The rest of the paper is structured as follows. Section III describes the methodology of the study highlighting the theoretical model of the CES production function, data sources, data collection procedure and other necessary information while section IV is dedicated for analyzing results of the work stating results of CES production function as aggregate as well as categories of farms. And finally section V concludes with some policy suggestions.

III. METHODOLOGY OF THE STUDY

3.1 The Theoretical Model (Formalization of the CES Model):

The Constant Elasticity of Substitution (CES) production function was first empirically used by **Arrow, Chenery, Minhas, and Solow (ACMS) in 1961**, who estimated, assuming profit maximization, perfect competition and constant returns to scale, that the production function is of the form **as (Kmenta, J., p-514, 1971)**.

$$Q = \gamma \left[\delta K^{-\theta} + (1-\delta) L^{-\theta}\right]^{-1/\theta} \text{ ----------- } (1)$$

Where Q, K, and L are respectively the value of output at constant prices, the services of actual capital inputs measured at constant prices and the actual labor inputs measured in physical units of labor. Equation (1) is reportedly homogenous of degree one. The technology embodied in it is depicted by three different parameters that are also assumed to be constant:

γ: Scale or efficiency parameter; $\gamma>0$

δ: Distribution parameter; also indicates the degree to which technology is capital intensive.

$1-\delta$: It indicates the degree to which technology is labor intensive.

θ: Substitution parameter.

The elasticity of factor substitution, a simple function of θ is given by the following expression:

$$\sigma = \frac{1}{1+\theta}$$

Equation (1) stated above, has been further generalized by Cani and Brown with the introduction of a fourth parameter h that measures the degree of homogeneity of the function in question or putting it differently the degree of returns to scale. The version of the CES relation introduced by them takes the form:

$$Q = \gamma\,[\delta K^{-\theta} + (1-\delta)\,L^{-\theta}]^{-h/\theta} \text{------------------- (2)}$$

In the original ACMS formulation h was treated to be one, thereby imposing the restriction of constant returns to scale. Taking the logarithmic transformation of the equation no (2) yields the expression:

$$\ln Q = \ln\gamma(-\,h/\theta\,)\ln\,[\delta K^{-\theta} + (1-\delta)\,L^{-\theta}] \text{----------- (3)}$$

Equation no (3) contains four parameters that summarize the feature of the prevailing technology integrate in the production function.

Usually the values of θ, the substitution parameter, range from -1 to ∞, which allows σ to range +∞ to 0. However, for $0< \theta <\infty$, we will have $\sigma < 1$ (ACMS, 1961, p.230).

However, due to the problems related to the capital stock variable e.g., adjustment of book value figures, lack of capital price deflators, adjustments for capacity utilization etc. we adhered to a specification where no capital input variable is directly required for estimation of the elasticity parameter (ibid.), **ACMS (1961, p.225)** demonstrate that the value added per unit of labor used within a given industry varies across countries with the wage rate. Their analysis is based on 19 different countries (ibid.).

Under the assumption of perfect competition in factor and product markets and constant returns to scale, the elasticity parameter can be indirectly estimated from the derived form of the CES production by using profit maximization condition of equating wages to marginal revenue product (ACMS, 1961). We attempt to choose a functional form which necessarily has the properties of (i) homogeneity, (ii) constant elasticity of substitution between capital and labor, and (iii) the possibility of having different elasticities for different industries (ACMS, 1961, pp.225-26).(Samad, Q.A. Jan.2003, p.3).

The mathematical procedure of obtaining the estimation form of the CES production function is based on the marginal productivity of labor relation derived from the equation. The estimated form of the function is:

$$\text{Ln}\,(Q/L) = a + b\text{Ln}W + u \text{------- (4)}$$

Alternatively,

$$\text{Ln}\,(Q/L) = \text{Constant} + \sigma\,\text{Ln}W + u \text{-------(5)}$$

Where,

b = σ = Elasticity of substitution

W = Real wage per employee

Q/L = Real value added per employee.

The coefficient of LnW in the above regression of Ln (Q/L) on LnW yields an estimate of σ. The possible values of ρ ranges from infinity to -1, when σ = 1 leads to Cobb- Douglas production function. It can be inferred from the partial elasticity of labor productivity that if σ is greater than 1, then there will be higher substitution possibilities and if σ is less than one, then there will be lower substitution possibilities.

The above equation will be estimated underlying the assumption of constant returns to scale. In most empirical cases relating to industry or agriculture, the CES production function is used to know the extent of substation possibilities between labor and capital. If the elasticity of substitution estimated from the CES production function is more than unity, then it can be concluded that the substitution possibilities will be more in favor of the labor input. If it is less than unity, then there will be low substitution possibilities in favor of labor input.

Yet we should keep in mind that the estimation of the above function by OLS method is subject to one way causation implying that labor productivity depends on real wage rate only. The variable real wage can be obtained by deflating the nominal wage rate or money wage rate (Money Wage / Price). Money wage in the present study is defined as wage divided by labor (Wage / Labor) and price equals price of product.

The above indirect specification of the CES production function (equation 4) has been widely used in empirical studies for the estimation of the elasticity of substitution in developing countries. An important advantage of this formulation is that, despite its restrictive assumption is that it does not require capital stock data, the estimation of which involves many problems especially in developing countries.

3.2 Estimation of CES Production Function:

By assuming two factors of production, capital (K) and labour (L), the CES production function in its general form may be written as:

$$\textbf{Ln (Q.P / L) = Constant + } \boldsymbol{\sigma} \textbf{ Ln (Money Wage / P) + u-------}(6)$$

Where,

b = σ = Elasticity of substitution as before,

Money Wage / P = Real Wage perEmployee,

W/L = Money Wage,

P = Price of Output Charged by Each Farm (Poultry Broiler or Layer)

Q = Physical Output i.e. Output of Poultry Meat or Egg by Each Farm

Q.P = Value of Outputby Each Farm (Poultry Broiler or Layer)

Q.P / L = Average Revenue Product of Labor i.e. ARPL by Farm wise

Q/L = Real value added per employee.

From the equation 6 we can have the Model for our poultry broiler and layer farm.Thus using data on output per farm and average monthly wage rates per employee, we may fit the model by applying the usual technique of Ordinary Least Squares regression (OLSR).

3.3 Materials and Methods

For the present study Savar and Dhamrai Upazilla under Dhaka district and Bajitpur and KuliarcharUpazilla under Kishorganje district were selected. The data was collected through random selection of poultry farmers which gave the opportunity for fifty poultry farmers from each district making a total of 100 poultry farmers i.e. fifty farmers located in Dhaka and the rest fifty from Kisharganj. Data collection was done by means of structured questionnaireandas for statistical package Stata 14 was applied.

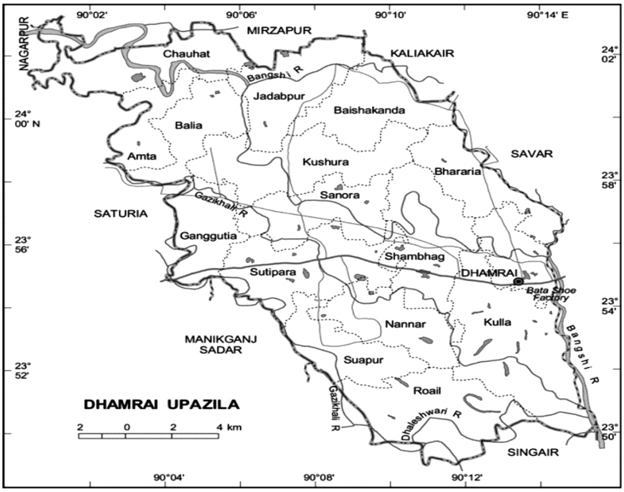

Figure 1: Site Map of Dhamrai Upazila

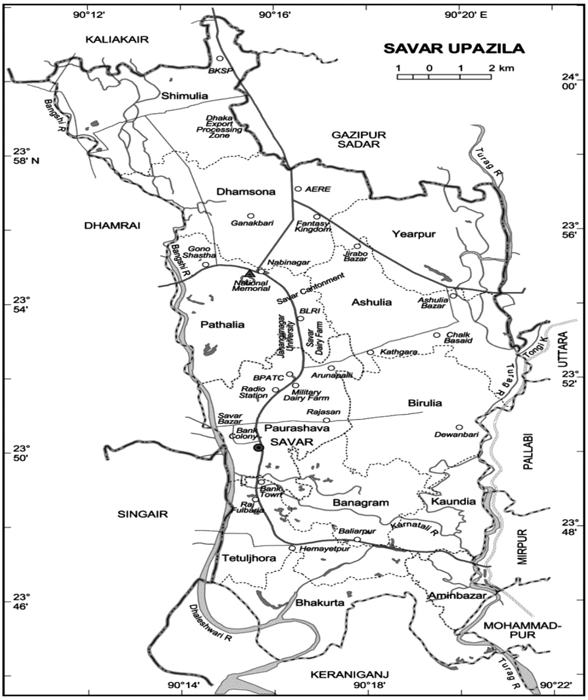

Figure 1.1: Site Map of Savar Upazila

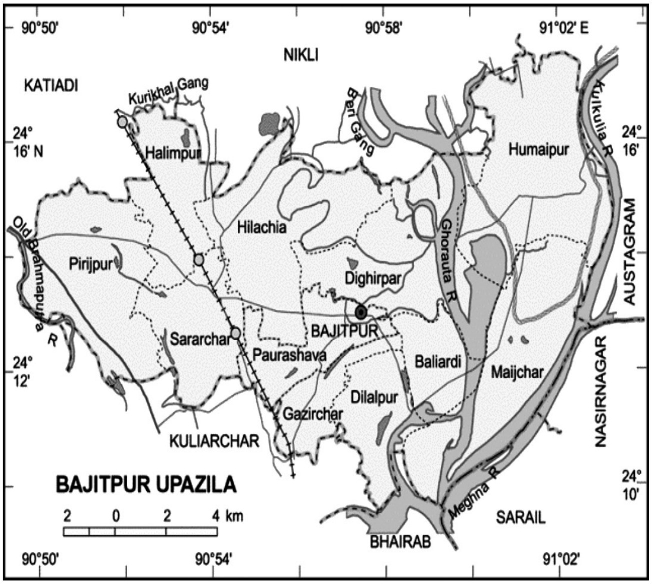

Figure 2: Site Map of Bajitpur Upazila

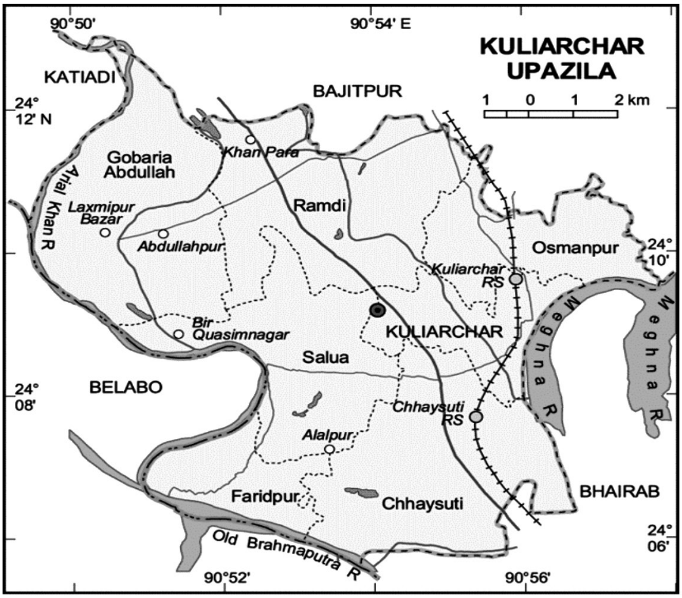

Figure 2.1: Site Map of Kuliarchar Upazila

3.4 Sources of Data

Poultry broiler rearers were the respondent of the study. So the primary data was collected from farmers involved in the production of poultry broiler meat. The data was collected from December 05, 2015 to March 20,2016. About 115 poultry farmers were selected and after necessary correction 100 poultry farmers were finalized for our research study.The collected data were studied by analyzinng mean, median, mode, outliers etc. Besides data were fitted for our study after taking necessary diagonestic treatment such as multicollinearity (VIF), hetroskedasticity etc. Finally the farms were categorized according to the number of birds reared in the farm followed by The Bangladesh Bureau of Statistics (BBS). As per as BBS the definition of different farms is as follows:

TABLE 1: CATEGORIZATION OF FARMS

No. of Birds	Categories of Farms
Up to1000 birds:	Small
1001-5000 birds:	Medium
Above 5000:	Large

Sources: Farm Poultry and Livestock Survey 2007-08" by BBS

The above definition of poultry farms was used during the study.

IV. ESTIMATES OF CES PRODUCTION FUNCTION

The section starts with the descriptive statistics of the study.

4.1 Descriptive Statistics of Broiler Farmers

Table 2 below shows the summary descriptive statistics of the broiler farms. The table shows that in the study area the mean flock size was 2,567 birds. The average year of experience of farmers was 5.4 years and the mean age of farmers was 40. The poultry farmer's average family size was 5.

TABLE 2: BROILER DESCRIPTIVE STATISTICS

Variable	Obs	Mean	Mean	Min	Max
Flock size	100	2567.1	2559.238	100	1000
Experience	100	5.423	3.260286	1	15
Age	100	40.13	7.34662	18	54
Family members	100	5.03	1.714201	0	9

Source: **Field survey, 2015-16**

4.2 CES Function for Broiler Farmers (Aggregate)

In this segment, we have estimated the constant elasticity of substitution production function empirically, for the production of broiler farm as aggregate, broiler small farm, broiler medium farm and broiler large farm based on our sample data by taking the **natural logarithm of the value of output per worker** (Average Revenue Product of Labor i.e. ARPL) as the dependent variable and that of average **real wage** (real wage was calculated considering the base year 2010-2011) per employee **as the explanatory variable**. We can get the log linear form of the estimated CES function from equation 6 as follows:

$$\text{Ln}\ (Q.P/L) = \text{Constant} + \sigma\ \text{Ln}\ (\text{Money Wage}/P) + u \text{-------}(7)$$

Where Money Wage/P = Real Wage for Broiler Laborer,

Money Wage =W/L;

P= Price of Product for Meat

Q.P / L = Average Revenue Product of Labor (ARPL) for Broiler Farm

It has already been discussed (in earlier discussions) that the Cobb-Douglas production function is an exceptional case of the CES production function with elasticity of substitution equal to unity. On the other hand, the CES production function can be viewed as an oversimplification of the C-D production function to the case of non-unity, but constant elasticity of substitution.

Having estimated the C-D production function based on composed data of a special sample of leather manufacturing, we made a drive to calculate approximately, following comprehensively the procedure cited above, the CES production function and to find out the corresponding elasticity of substitution for different stage of leather manufacturing industries.

We have prepared a wide use of multiple regression analysis contained by the framework of the method of Ordinary Least Squares (OLS) for our present study. Regressing average annual wage per employee rates on output per employee in each category of poultry farms for both broiler and layer production. We receive the asking CES production functions and the corresponding elasticity of substitution (as shown by coefficients of wage rate) for each case in the model.

4.3 CES Function for All Broiler Farms (Aggregate CES Function)

First of all we have estimated CES function for all broiler farms in the study area as a whole i.e. aggregate CES function. For this purpose we have used the following regression equation:

$$\text{Ln (Q.P /L)}_{\text{Aggregate}} = \text{Constant} + \sigma \text{ Ln (Money Wage/P)}_{\text{Aggregate}} \quad \text{……..(8)}$$

Table 3 below shows the estimated CES production function for all broiler farms. The coefficient of the real wage rate (0.918) that indicates a direct estimate of the elasticity of substitution (б) approaches to unity. Where we see that for broiler aggregate, the elasticity of substitution with respect to real wage rate significantly differs from zero at 1 percent level of significance confirming substitutability between capital and labor. The value of elasticity 0.918 which is near about unity indicates a near proportional relationship between real wage rate and labor productivity changes. The substitution value is near unity implying that the substitution (of capital for labor) has become easier in this case of broiler meat production. This shows that a one percent increase in money wage rate leads to increase the labor productivity by 0.918 percent. The R^2 shows that labor productivity changes are also explained by measured factors in the model.

TABLE 3: CES FUNCTION FOR BROILER AGGREGATE FARM

$$\text{Ln (Q.P / L)}_{\text{Aggregate}} = \text{Constant} + \sigma \text{ Ln (Money Wage / P)}_{\text{Aggregate}}$$

Number of Observation = 100

F (1, 98) = 139.86

Prob> F =0.0

R-squared = 0.622

Adj R-Squared =0.608

ln(Q.P / L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	0.918328	0.2223038	4.130959525	0.00007637
_cons	2.0084	0.2226249	9.021452677	0.00

Source: Author's Calculation

Now then we have estimated CES function based on category of farms i.e. small, medium and large farms respectively to see whether value of elasticity differs across categories.

4.4 CES Function for Broiler Small Farm

The regression results of the CES production function (table 4 below) shows that the regression coefficient of log wage rate 0.78, which is constant elasticity of substitution, is significantly different from unity confirming that the choice of the CES production function is correct. But the lower value of the elasticity of substitution (0.78) implies that it seems to be really tough to substitute capital for labor i.e. the extent of possibility of factor substitution is lesser in case of broiler small farm production.The value of coefficient shows that a one percent increase in money wage rate leads to increase the labor productivity by 0.78 percent. The R^2 shows that 61 percent of the changes of the dependent variable are explained by the independent variables in the model.

TABLE 4: CES FUNCTIONFOR BROILERSMALLFARM

Ln (Q.P / L) Small = Constant + σ Ln (Money Wage / P) Small

Number of Observation = 42

F (1, 40) = 62.56

Prob> F =0.0

R-squared = 0.61

Adj R-Squared =0.590

ln(Q.P /L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	0.780	0.222	3.512	0.001
_cons	2.000	0.266	7.507	0.0

Source: Author's Calculation

4.5 CES Function for Broiler Medium Farm

The regression results of the CES production function (table 5 below) shows that the regression coefficient of log wage rate 0.886, which is constant elasticity of substitution, is significantly different from unity confirming that the choice of the CES production function is correct. But the lower value of the elasticity of substitution (0.886) implies that it seems that the extent of possibility of factor substitution is lesser in this case. The R^2 shows that 61 percent of the changes of the dependent variable are explained by the independent variables in the model.

TABLE 5: CES FUNCTIONFOR BROILERMEDIUMFARM

Ln (Q.P / L) Medium = Constant + σ Ln (Money Wage / P) Medium

Number of Observation = 32

F (1, 30) = 51.08

Prob> F =0.0

R-squared = 0.602

Adj R-Squared =0.588

ln(Q.P / L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	0.886	0.298	2.970	0.005
_cons	1.880	0.127	14.775	0

Source: Author's Calculation

4.6 CES Function for Broiler Large Farm

The regression results of the CES production function (table 6 below) shows that the regression coefficient of log wage rate 1.21, which is significantly different from unity confirming that the choice of the CES production function is correct. The value of substitution is positive and larger than unity emphasizing the fact that the substitution possibilities are more in favor of labor than capital.The higher value of the elasticity of substitution in this case, in turn, implies that it has become relatively easier to substitute capital for labor i.e. possibility of factor substitution tends to be higher in case of large farm in comparison with the earlier two categories of farm (small and medium farm). The value of coefficient 1.21 shows that a one percent increases in money wage rate leads to increase the labor productivity by 1.21 percent.We can also say that labor productivity in this case is relatively more elastic to the changes in money wage rate.

TABLE 6: CES FUNCTION FOR BROILER LARGE FARM

Ln (Q.P / L) Large = Constant + σ Ln (Money Wage / P) Large

Number of Observation =26

F (1, 24) = 31.81

Prob> F =0.0

R-squared = 0.597

Adj R-Squared =0.569

ln(Q.P / L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	1.212	0.488	2.483	0.020
_cons	3.003	0.199	15.075	0.0

Source: Author's Calculation

V. CONCLUSION AND POLICY IMPLICATIONS

For the case of Bangladesh broiler meat production, this paper makes the first attempt to estimate the CES production function with the objective of finding out the elasticity of substitution for capital and labor.From our study we have found that the magnitude of the elasticity is significantly less than unity in case of broiler aggregate i.e. 0.91 and broiler small and medium farms i.e. 0.78 and 0.886 respectively (table 2 and 3 correspondingly). This implies inelasticity for farm inputs which in turn leads to conclusion that it seems to be really tough to substitute capital for labor i.e. the extent of possibility of factor substitution is lesser in case of broiler small and medium farms. On the other hand,in case of large farms the elasticity magnitudewas positive (1.212 mentioned in table 4) and significantly larger than unity meaning high flexibility with respect to relative factor price i.e. emphasizing the fact that possibility of factor substitution tends to be higher in case of large farm in comparison with the earlier two categories of farm (small and medium farm). All these suggest that there is high output rate in case of broiler large farms specially compared to medium and then small farms.

As the wage to rental rate ratio changes, the sector with a higher elasticity of substitution between capital and labor – is in a better position to take advantage of these changes than the less flexible one. Due to the least per unit cost, reduced managerial cost in long run large farms face more efficiency than do medium and small farms. The smallholder broiler farmers are characterized by poor production process, low production quantities thus slow growth. That's why small farms (and medium farms also) demand special nurture and policy support from the govt..We need to keep in mind that small scale poultry enterprise play pivotal role for rural people especially illiterate, women and youth through generating employment opportunity. And small farm in this sector can reduce the rate of poverty enormously. If small farms were provided capital or capital machineries, equipment, modern technologies they could also do better and can survive in the market in long run. Our findings indicate the urgency of doing something particularly for the small farms from the govt. at a large scale. In this regard govt. can nurse the small poultry farms across the country through providing budgetary allocation as for poultry subsidy.Poultry Insurance can also be considered and may be introduced in this regard mainly underlining on small farmers.

The long-term position of Bangladesh as a prominent producer of poultry products leftovers bright even after the bird flu epidemic that has held off its prospect. The swelling demand for poultry meat and eggs has improved poultry activity into a full-grownindustry from a mere household activity until recently.This is the high time for govt. to take all necessary policy steps regarding poultry sector particularly emphasizing on the availability of quality chicks and feed, vaccination service by dept. of livestock, tax exemption and providing subsidy, introducing poultry insurance and finally creating a poultry friendly environment. The findings would contribute toproject the Bangladesh's effective policies on poultry broiler production with the appropriate allocation of inputs factors in order to achieve the optimal output. All categories of All categories of stakeholders should partake in policy formulation for the development of the poultry industry. stakeholders should partake in policy formulation for the development of the poultry industry. The sector will contribute more than it is expected to be if proper policy is taken and will contribute to the country's GDP leading a strong domestic economy of the country.

However, in the present paper we have studied 100 broiler farms and conducted our research work based on only two regions (such that Dhaka and Kishorganj). One can carry the same study more vigorously by incorporating more farms and raising the number of research region. If that one is possible we would have better result. Besides, in the current work we have studied only broiler not layer farms. Researchers interested in this industry can go for studying poultry layer farms to see the magnitude of the elasticity in that case. So then we can have an overall picture of the poultry industry in Bangladesh.

REFERENCES

Ahmed S. & N. Islam. (1985, February). *Backyard poultry development project in 100 villages.* Proceedings of the 1st Conference of Bangladesh Animal Husbandry Association. February 23-24. BARC. Dhaka 133-138.

Ahmed, M.F.U. (2001). *A comparative Economic analysis of broiler production under PROSHIKA supervision and private management in some selected areaTangial district.* M.S. Ag. Econ.Thesis, Dept. Of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.

Akter N et. Al., (2004). Challenging the frontiers of poverty reduction/target ting the ultra-poverty program, BRAC .

Alam , S.M (2004). *A study on backward and forward linkage of poultry farming in some selected areas of saver Upzilla under Dhaka district.* M.S. Ag. Econ.Thesis, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.

Arrow, Chenery, Minhasand Solow, (1961, August). Capital-Labor Substitution and Economic Efficiency, *The Review of Economics and Statistic,* Vol. XLIII, No. 3.

Bairagi, S. K. (2004). *An economic study of contract broiler farming with references to supply chain management.* M.S. Thesis, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.

Balestreri et al. (2003). An Estimation of U.S. Industry-Level Capital-Labor Substitution Elasticities: Suort for Cobb-Douglas, *The North American Journal of Economics and Finance*, 14(3), 343-356.

Battese and Sohail J. Malik (1986, April). Estimation of Elasticities of Substitution for CES Production Function Using Aggregative Data on Selected Manufacturing Industries in Pakistan, No: 6.

Battese G.E., and S.J. Malik (1988), "Estimation of Elasticites of Substitution for CES and VES Production Functions using Firm-level Data for Food Processing Industries in Pakistan, *Pakistan Development Review*" XXVI:2.

Begum I.A. and Alam M. J. (2000). Contract farming and Small Farmers: Case Study of the Bangladesh Poultry Sector.

Bhuiyan, A.H (2003). *A comparative analysis of poultry under supervision of AFTAB Bahumukhi farm and own management in some selected areas of Kishorgonj district.* M.S Ag. Econ.Thesis, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.

Binswanger, H. P. (1973). *The Measurement of Biased Efficiency Gains in US and Japanese Agriculture to Test the Induced Innovation Hypothesis.* Unpublished Ph.D. dissertation, North Carolina State University, Raleigh.

Brown, R. S. (1978). *Productivity, Returns and the Structure of Production in the US Agriculture,* 1947-74. Unpublished Ph.D. dissertation, University of Wisconsin, Madison.

Cobb, C. W., Douglas, P. H., (1928). A Theory of Production. *The American Economic Review* 18 (1), 139-165.

Ershad, S.M.E. (2005). An article on performance of hybrid layers and native hens under farmers' management in a selected area of Bangladesh. *International Journal of Poultry Science* 4 (4): 228-232, 2005. © Asian Network for Scientific Information, 2005.

Ferguson, C. E., (1969). The Neoclassical Theory of Production and Distribution, Cambridge University Press, London

Hassan Md. M., (2018). Application of Stochastic Frontier Model for Poultry Broiler Production: Evidence from Dhaka and Kishoreganj Districts, *Bangladesh, Bangladesh Development Studies*, Vol. XLI,March 2018, No.1.

Hildebrand, G.H. and T.C. Liu, (1965). Manufacturing Production Functions in the United States, Ithaca, New York State School of Industrial Labour Relations.

Jabbar Mohammad A., et. al. (2007). Formal and informal contract farming in poultry in Bangladesh", *World Poultry Journal.*

Islam K. M. Nabiul (2001). Demand for Poultry Feeds: Implications For Wheat and Maize Production in Bangladesh.

kazi, S., Z. S. Khan and S. A. Khan (1976). Production Relationships in Pakistan's Manufacturing, *Pakistan Development Review*. XV:4.

Khan M. M. et. al. (2006). The Status of Homestead Poultry Production in Sylhet Region, *International Journal of Poultry Science* 5 (11): 1092-1095, 2006.

Klump and De La Grandville, (2000). Economic Growth and the Elasticity of Substitution: Two Theorems and some Suggestions, *American Economic Review,* 90(1), 282-291.

Kmenta, J., (1971). Elements of Econometrics, New York: Macmillan Co.

Raihana (2012). Factor Substitution and Technical Change in Bangladesh Agriculture, *Bangladesh Development Studies*, Vol. XXXV, December 2012, No. 4.

Miah, M.T.H. 1990. Economics of commercial poultry farming in Bangladesh, Report No. 21, Bureau of Socioeconomic Research and Training, Bangladesh Agricultural University, Mymensingh.

Morawetz, D. (1976). Elasticities of Substitution in Industry: What do We Learn from Econometric estimates?, *World Development*, 4 (1), 11-15.

Nerlove, M., (1967). Recent Empirical Studies of the CES and Related Production Functions, in Brown (ed) The Theory and Empirical Analysis of Production, National Bureau of Economic Research, New York , Columbia University Press.

Rahman B. et. al., (2009). A study on profitability of contact broiler farming system at Bajitpur", *Bangaldesh Journal of Livestock Research*, vol- 16 (1&2), pp. 105-108.

Shamsuddoha M. (2009). Development of Livestock Sector Through Leading NGO in Bangladesh, The Annals of the Stefan cel Mare, University Suceava, Fascicle of the Faculty of Economics and Public Administration.

Shah S, Sharmin, M. and Haider, S. (2011). Problems of small to medium size poultry farms– Bangladesh perspective, Department of Pharmaceutical Technology, Faculty of Pharmacy, University of Dhaka, Bangladesh.

Ukil, M. A. and Paul, D. C. (1994, December). Problems and prospect of poultry industry in Chittagong region‘, Papers presented to the Bangladesh Animal Husbandry Society Conference, Dhaka, 1994.

Uddin, Hossain, Hasnain, (2017). Efficiency of Maize Production in Bangladesh: A Stochastic Frontier Approach",http://www.sb.iub.edu.bd/wp-content/uploads/2017/12/7V.pdf

USAID-ATDP (2005). Issues and Interventions in Poultry Sector Final Report, USAID - ATDP II Undertaking.

Wadud, A., and B.White. (2000). From Household Efficiency in Bangladesh: A Comparison of Stochastic Frontier and DEA. *Applied Economics* Vol (32), No. 13 pp. 1665-1673

Walters, A. A., (1963). Production and Cost Functions: An Econometric Survey, *Econometrica*, Vol. 31, pp. 1-66.

Wyzan, M. L. (1981). Empirical Analysis of Soviet Agricultural Production and Policy." *American Journal of Agricultural Economics*, 63: 475-483

Zaman S. A. Uz (2007). The Potential of electricity generation from poultry waste in Bangladesh: Case study of Gaipur District.