AN ANALYSIS OF TECHNICAL EFFICIENCY OF POULTRY FARMING INDUSTRY IN NEPAL

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LETTER OF RECOMMENDATION

This Thesis entitled "AN ANALYSIS OF TECHNICAL EFFICIENCY OF POULTRY FARMING INDUSTRY IN NEPAL" has been prepared by Mr. Nripesh Bahadur Pradhan under my guidance and supervision. I, hereby, recommend it, in partial fulfillment of the requirement for the Degree of Master of Arts in Economics for final examination.

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Dr. Nirmal Kumar Raut

Thesis supervisor.

Date:2077/02/32

LETTER OF APPROVAL

We certify that this thesis “AN ANALYSIS OF TECHNICAL EFFICIENCY OF POULTRY FARMING INDUSTRY IN NEPAL” is submitted by Mr. Nripesh Bahadur Pradhan to the Central Department of Economics, Tribhuvan University, in partial fulfillment of the requirements for the Degree of Master of Arts in Economics has been found satisfactory in scope and quality. Therefore, we accept this thesis as a part of the said degree.

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ABSTRACT

The commercial poultry is growing rapidly. It is essential to achieve highest possible output to increase productivity and profit. The goal of the study is to estimate the technical efficiency of the poultry industry and its distribution spatially across the districts. The study utilizes Cobb-Douglas model to defined the structure of the production model and its error term is assumed to follow exponential distribution. Thereafter, using maximum likelihood estimator, Stochastic Frontier Method is applied to data obtained from Nepal Commercial Poultry Survey 2015 (CBS, 2016). The technical efficiency and inefficiency estimated using Jondrow et al., (1982) method at 90.51 percent and 10.26 percent respectively. However, only 41.24% of the compound error were explained by the technical inefficiency. Further disaggregation of technical efficiency by districts shows its homogenous distribution across different districts.

Keywords: Poultry, Technical efficiency, stochastic frontier, homogenous

CHAPTER I
INTRODUCTION

1.1.BACKGROUND

Raising fowl and other livestock at own backyard is a common trait of Nepalese society. In rural areas, it is natural to find few livestock in each household. It serves as primary source of the protein diet and extra income for the household.

There are two patterns of poultry farming 1) scavenging and 2) commercial. In rural area, besides the feed provided by the farmer, chickens freely scavenge the nearby kitchen garden and farm for foods. Scavenging poultry farmer only rear few fowls mainly for domestic consumption. In case of commercial chicken farming, chickens are raised in large stock. Scavenging is not a viable option. Fowls required the large quantity of feeds with sufficient nutrient contain (Acharya & Kaphle, 2015).

The commercial poultry farm in Nepal was formally initiated in 1957/58. The government established and operated the central hatchery in Parwanipur with the support of USAID. One of the advantages of the poultry farming is low gestation period for poultry farmer. Investor can expect the return on their investment in short period of time. The World Bank (2020) states that gross National Income (GNI) per capita, adjusted with PPP was increased from $1910 in 2010 to $3600 in 2019. Increase in the purchasing power of the Nepalese people helped to improve their living standard. This is because meat and eggs are considered high standard food product and preferred consumption on various auspicious occasion. It has positive impact on demand for chicken products and incentivize the entrepreneurs to enter or expand the business. The data show the fowl population had increased from 25.7 million in 2009/2010 to 40 million in 2010/11 and show steady growth reaching 70 million in 2016/2017.

Similarly, chicken meat production show rapid growth from 16712 Metric tons (Mt.). in 2007/08 to 57268 Mt. in 2016/17 and egg production from 617455000 in 2007/08 to 1338312000 in 2016/17 (MoALC, 2018).

Commercial poultry farm in Nepal produced the 4.1 kg of meat and 44units of eggs per year per person (CBS, 2016) i.e. lower than the global average of 12 kg of meat and 153 units of eggs. There is a lot of potential for further growth. But actual growth is linked with the profitableness of the poultry farms. Profitability is the difference between the cost of production and the return. A.D. Davey (1948) states that each steps from breeder to hatchery and then to poultry farmer are important to produce desired output. If there is a demand for large size egg, it will be inefficient to select the only large size egg to sell in the market. Instead farmer could purchase specific breed of chicken that would lays such eggs. With proper feed and care s/he could produced desired number of eggs at preferable price that satisfied the demand of the final consumer. Satisfaction of consumers ensure sustenance and growth of the poultry farms and hatcheries. Therefore, efficiency in each step from breeder, hatchery to poultry farm is essencial for success of poultry industry. Efficiency is described as the ability to maximize output from minimum inputs. The inputs can be number of stock of birds, labor, feed and e.t.c. Efficient operation of the poultry farm help to increased the productivity, lower the cost of production and increased the scale of profits.

Empirically, no business can run in 100% efficiency. The production process produced certain amount of by-product. Certainly, not all byproducts are waste. In poultry industry, by-product like feces is sold as a manure and down feather for jacket, blanket and pillows. It provides extra income to the farmers. Any inefficiency signifies the underutilized of the resources to produce the specific product. The price of the product does not exclude the loss due to inefficiency.

Efficiency can be optimized by ensuring the farmer acquired right breed of chicken. Today there are 128 hatcheries supplying 21956 of poultry farm in different part of Nepal (CBS, 2016). Establishment of the hatchery helps to dictate the term of quality of the chicks' rear in the country and reduce the cost of production. It is far cheaper and sustainable option.

Environment also impact the production of egg and meat. The stock of fowls in sanitary environment have lower mortality rate. Proper management of bio-securities reduces chance of infection from deadly diseases like bird flu. Stock of birds also require sufficient quantity and quality of feed supplement. Labors manage these resources. It is in their self-interest to maintain and operate every machinery and equipment at top efficiency. It affects the labor efficiency and help to avoid uncertainty risk in the future. Labors should be trained and re-trained to better performed the daily work and avoid any bottle-neck.

An efficiency can be categorized as allocative efficiency and technical efficiency. The technical efficiency means process of obtaining the optimum production of the output without increasing the input under a current technology. The technical efficiency can be estimated using different models. The Stochastic Frontier Analysis (SFA) is one of the recommended methods. Here, error component is separated into noise and technical inefficiency. Noises are the random error that is beyond the control of farm and technical inefficiency is caused due to the deficiency within the farm. The technical inefficiency is used to estimate the technical efficiency (TE). The TE lies between 0 and 1. One means the full efficiency while zero means the opposite.

The estimates of the technical efficiency also help in designing future policy and strategy. It helps to rank the producer according to efficiency level and regulate the industries. Tougher regulation could be set for the inefficient industries to discouraged the owner from transferring the miss-managed loss onto the customers (Kumbhakar & Wang, 2010).

1.2. STATEMENT OF THE PROBLEM

Per capita consumption of meat and eggs of Nepal is 4.1 kg and 44 eggs respectively which are below the global average i.e. 12 kg of meat and 153 units of eggs. This shows the poultry industry still have more potential to grow. A lot of literature highlights the potential and attraction of poultry business. They highlight the need for better quantity and quality of feed, improved breed and better technology. In other side, Poultry industry also need to work as efficiently as possible. The technical efficiency of the firm determines its ability to produce output with minimum loss of input.

Given these backgrounds, this study tries to answer the following research questions.

- What is the technical efficiency of the poultry industry?
- How does the technical efficiency differ spatially across districts?

1.3. OBJECTIVES

The objective of the research is to establish the technical efficiency of the poultry industry. The objective is further classified as follows:

- To estimate the average technical efficiency of the poultry industry.
- To further understand the heterogeneity in technical efficiency across districts.

1.4. SIGNIFICANCE OF THE STUDY

This study estimates the technical efficiency of the poultry industry in Nepal. The technical efficiency is very useful to understand the ability of the industry to produce output with minimum loss. The statistic obtained is helpful to both government and the firm. It might help government to plan the targeted strategy to improve the deficiencies in the industry. In case of firm, presence of low efficiency, show the need of training, quality breed of chicken and better managerial practice to handle the resources. If the efficiency is already high, the better technology or increased input will increase the output.

This study might be first in Nepal in estimating the technical efficiency of the poultry industry. It will provide different insight into poultry industry of Nepal for planning and policymaking and future research.

1.6. LIMITATION OF THE STUDY

The study is limited to the scope of the data available and the objective mention above. The solely rely on the data from the report "Nepal Commercial Poultry Survey 2015{NCPS 2015}" prepared by Central Bureau of Statistic (CBS, 2016). The report was prepared for the period of 2071/72 BS and it include data on 64 districts. Therefore, the technical efficiency estimated will automatically explained the technical efficiency of that period. Also due to the nature of the data available, it was impossible to estimate the technical efficiency of each firm. Instead, each district was taken a sampling unit. The technical efficiency of each district was estimated.

1.7. HYPOTHESIS

The study is about the technical efficiency of the poultry industry in Nepal. Here we assumed that the farmer could utilize the input to its full potential and acquired maximum output. The hypothesis assumed the production process suffer zero loss due to technical inefficiency. Thus, H_0: u = 0

H_1: u ≤ 1

(H_0 = Null hypothesis, H_1 = Alternate hypothesis & u=technical inefficiency)

1.8. ORGANIZATION OF THE STUDY

The study is categorized into five chapters. The first chapter includes background, statement of the problem, objective of the study, significance of the study, limitation of the study and organization of the study. The chapter two was concern for reviewing the available literature. Review of books, journals (articles), thesis etc. were included in this chapter.

Chapter three presents the methods used on conducting the study. In this chapter the research methodologies that were used for the analysis was discussed. This chapter include conceptual framework, research design, sample size and sampling procedure, data analysis and management and specification of the model used for analysis in order to meet the objectives. The fourth chapter include the data analysis and result. This would be the main body of the research. In this chapter, data collected was analyze.

Chapter five summarized the analysis as per the objectives and the hypothesis. The last chapter include conclusion and recommendation along with the Bibliography and appendix are at the end.

CHAPTER II
REVIEW OF THE LITERATURE

2.1. THEORETICAL REVIEW

Various literature defined the technical efficiency as the relation between the actual output and the potential output possible. Foremost, a pre-defined technology utilized prerequisite ratio of resources to produce an output. In this production process, technical efficiency displays the ability of the firm to produce output with minimum loss (Kumbhkar et al., 2015).

There can be various technology with different sets of inputs for the desired output. The selection of the best technology is a technical problem (Henderson & Quandt, 2013). Production function is the prerequisite relation between the inputs and outputs. In fact, the whole economy is about the transformation of the inputs into the different product through the pre-define production process. Those inputs are known as the factor of production. It includes Land, Labor, Capital and organization. The structure of production function can be defined using different production model. In case of the estimation of the stochastic frontier and technical efficiency, numbers of literature often utilized Cobb-Douglas model or trans-log model (Greene, 2008).

$$Y=f\ (X_i) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1).$$

Where, i= (1, 2, 3, 4, 5….),

Equation (1) represents the general formula of the production function. Y is the output produced and f (X_i) is the inputs process and technology utilized. X_i includes the different quantity of inputs and their organization.

Greene (2008)) and Kumbhkar et al., (2015) state that the production function is a mathematical interpretation of the production process and the efficiency is ability to produce higher output utilizing the minimum inputs. If the actual output of the firm is equal to the theoretically obtained output, then the firm is 100% efficient.

The empirical study shows that the firms usually produced at the lower level than the frontier level. But, the neo-classical production theory assumes the market always correct the inefficiency and the production activities are carried out at frontier level. It couldnot explain the actual firm situation. The production efficiency literature relaxes on this assumption. It consider the possibility that producers may operate below the frontier due to technical inefficiency. (Kumbhakar & Wang, 2010)

The efficiency can be further categorized as the allocative efficiency that deal with having the right quantity and quality of inputs and technical efficiency that deal with technology used and how efficiently. The technical efficiency can be estimated using input oriented or output oriented technical efficiency methods. Input oriented technical efficiency tried to minimized input for observed output and output oriented technical efficiency tried to maximize the output for the given inputs. We can use both non-parametric and parametric method to estimate the output oriented technical efficiency. Non-parametric method includes Corrected ordinary linear system (COLS) and Corrected mean absolute deviation (CMAD). Parametric Method includes stochastic frontier method.

$$Y_i = f(X_i, \beta) \exp(-u_i) \_\_\_\_\_\_\_\_\_ 2$$

$$TE = \exp(-u_i) = \frac{f(Xi, \beta)}{Y_i} \_\_\_\_\_\_\_\_\_\_ 3$$

Equation (2) represent the deterministic production model. Equation (3) show the technical efficiency derived from equation (2). $-u_i$ show the technical inefficiency, exp ($-u_i$) show the technical efficiency also represent by TE (Kumbhakar & Lovell, 2000).

Aigner et al., (1977) and Meeusen & Broeck (1977) were the first to utilize the stochastic frontier model. Non-parametric approach like COLS and CMAD are deterministic. Any shortfall to achieve the potential output, fall onto inefficiency. Deterministic frontier model doesnot differentiate between random shock and the actual technical inefficiency. It ignores the effects of the random shock like environment, natural disaster on the production process. Stochastic frontier model error terms includes the random shock and technical inefficiency. Both error terms together known as composed error. Here, the frontier of each firm can varry from other and its self over the time period. It is caused due to the presence of the random shock. Thatwhy, the model is called as the stochastic frontier model.

$$LnY_i = x_i\beta+\varepsilon_i \quad \_\_\_\_\_\_\_\_ 4$$

$$\varepsilon_i = v_i - u_i \quad \_\_\_\_\_\_\_ 5$$

Equation (4) shows the log linear form of the production function. ε_i represent the composed error, v_i is the two-sided error representing the symmetric disturbance. It is independently and identically distributed {N $(0,\sigma_v^2)$} and u_i is one-sided error point representing the technical inefficiency. It is also independently distributed ($u_i \geq 0$). The technical inefficiency error term is non-positive disturbance, which reflect the fact that the output cannot raise above its frontier.

One of the significances of the stochastic frontier model is the separation of the technical efficiency from the other shock like weather variation, variation in labor and machine performance or just plain luck. Nevertheless, it is problematic to decompose the compound error ε_i into the two components u_i and v_i as state in equation (5). The average of the $\widehat{\varepsilon_i}$ helps to estimate the average technical inefficiency but it is more desirable to have the technical inefficiency of each observations (Kumbhakar & Lovell, 2000). Distribution assumption about the error term help to identify the two error terms. u_i error term is independent of v_i. The v_i is widely accepted to have a zero mean normal distribution. The distribution assumption made helps to derive the technical inefficiency in the production function. Generally used distribution assumption are as follows:

1) Half-Normal Distribution
2) Truncated- Normal Distribution
3) Exponential Distribution

Assumption made, help to derive the log-likelihood function of the model. Afterward, using the maximum likelihood method, we estimate the model parameters. The whole process is tenacious. A simple skewness test could help a lot to ease the process. The skewness test utilized the OLS residual to test its skewness. The stochastic frontier contains two-error term and equation (5) describe their relationship. If $u_i = 0$, then $\varepsilon_i = v_i$. It shows the error is symmetric and without any technical inefficiency. However, if $u_i \geq 0$, then $\varepsilon_i = v_i - u_i$ is negatively skewed. It shows the presence of the technical inefficiency. However, the skewness does not consider the distribution pattern. Likelihood ratio test help to overcome shortcoming of skewness test. The log-likelihood ratio test requires the log-likelihood value of both OLS regression and stochastic frontier model. Therefore, we can only calculate the ratio after running the maximum likelihood estimates. It is a long process and that’s only drawback of the log-likelihood ratio method. (Kumbhkar et al., 2015).

The estimated value of variance of technical inefficiency (σ_u^2) is enough to estimate the average technical inefficiency. However, it is not enough to estimate the technical inefficiency of each observation. Jondrow et al (1982) proposed to estimate the value of u_i from the conditinal distribution of u_i given ε_i. Either mean or mode of the distribution can be used to estimate inefficiency of each observation.

$$E\left(\frac{u_i}{\varepsilon_i}\right) = \frac{\sigma_* \o(\frac{\mu_{*i}}{\sigma_*})}{\Phi\frac{\mu_{*i}}{\sigma_*}} + \mu_{*i} \text{ (for half-normal distribution and truncated-nornal distribution)}$$

$$E\left(\frac{u_i}{\varepsilon_i}\right) = \frac{\sigma_* \o\left(\frac{\mu_{*i}}{\sigma_v}\right)}{\Phi\left(\frac{\mu_{*i}}{\sigma_v}\right)} + \mu_{*i} \text{ (for exponential distribution (Jondrow et al, 1982))} \quad \text{— (6)}$$

2.2 EMPIRICAL REVIEW

Binuomote et al., (2008) studied about the technical efficiency of the poultry producer in Oyo state of Nigeria. They utilized the Maximum likelihood Estimate technique to estimate the stochastic production frontier model. The study concluded that the producers could increase the production and income by 17.7% at current level of technology and resources. Education and the family size or labor availability also helped to increase the technical efficiency. The study has concluded that the increased in the stock of birds and quality feeds push the production function to the maximum level.

Alani (2012) studied the effect of technological and productivity on the economic growth in Uganda within the 1971-2009 period. The study found the positive effect of technological progress and the reverse effect on the increase productivity of capital and labor on economic growth. The method estimated the contribution of technological progress in economic growth is often based on the improved Cobb-Douglas production function by Tinbergen. The study showed the technological progress, capital productivity and labor productivity caused increased in output by 2.4, -0.7 and -0.8 percent respectively. The 1 percent increase in technological progress could more than double the output. The capital growth, labor growth or technological progress results in economic growth.

Todsadee et al., (2012) analyzed the production efficiency of the poultry farming in the Thailand using the Stochastic Frontier model. The Maximum likelihood simulation model used to estimate the parameters. The result show that the mean technical efficiency of poultry farm is at 79% of efficiency. It shows the opportunity to improve the output level. The study showed the social-economic variable like education, age of farmer, access to credit had a position effect on the efficiency level. In production variables, feed cost, bird stock, variable and fixed cost are significant. But the labor show individually insignificant and was not used in the analysis of the study.

The study done by Ezeh et al., (2012) in Abia State, Nigeria showed the low productivity and inefficiency in resource allocation and management. The Cobb-Douglas stochastic production frontier is utilized to measure the technical efficiency. The study showed the efficiency between 0.9% to 97% and average efficiency at 75%. The efficiency was linked to the production factors i.e. stock size, feed intake, labor input highly influenced output. Study showed the negative relationship between level of education and technical efficient and also between age of farmer and technical efficiency. But show the positive relationship between the household size and technical efficiency.

Trujillo & Iglesias, (2013) studied the causes of deterioration in productivity of pineapple farm in Santander even though the land for cultivation was increased.

Colombia is ranked 12th in the production of the pineapple. It is the sixth most important fruit crop. However, in 2009, there was a moderate fall in the yield. They quantified the efficiency of the small pineapple farmer from department of Santander, using econometric method to estimate the stochastic frontier production function and technical efficiency model. A production frontier with a Cobb-Douglas functional form was utilized with the inputs such as labor, the number of seeds, and the quantity of defensives to determine the efficiency. The study shows the technical efficiency varies from 11% to 95% and all the inputs were significant and the level of education of small farmer was low. The government should make effort to increase the education level and also provide various technical training.

Bethel et al., (2016) analyzed the technical efficiency of poultry farmers in Cross River State, Nigeria. They analyzed the technical efficiency using the Cobb-Douglas Stochastic frontier production model. Maximum likelihood estimated in used to estimate the coefficients. The technical efficiency of the poultry farmer was 58%. The efficiency could be increased by 42% from the current technology and resources input. The variables such as feeds, access to membership, access to credit, veterinary services, chick, labor, etc. had positive impact on the level of technical efficiency.

Osti et al., (2016) estimated the efficiency and effectiveness of poultry farming. The objectives was to study the socio-economic characteristic of the poultry farm and estimate efficiency, cost and return from poultry farming. The area of study was chitwan district. For the purpose of the study, samples were selected using the stratified random sampling method. Primary data were collected using schedule. The study showed the social factor like are of farmer, family size and number of layinng birds significants affect the production. Production efficiency were estimated using the Feed conversion ratio, egg-feed price ratio and benefit-cosst ratio. The study show that the feed-convertion ratio value is relatively high in chitwan district. Feed cost occupy the biggest percent of the variable cost. The profit margin of the poultry farm increased with its size due to its higher mass of egg productionand lower conversion ratio.

2.3. RESEARCH GAP

The estimation of the technical efficiency in widely used in different field of study. It is very useful in understanding the efficiency of the firm and the effect of different variables on the efficiency of the firm. In case of Nepal, there are few literatures on technical efficiency. None used the stochastic production method to estimate the technical efficiency of the poultry industry in Nepal.

This might be the first study to estimate the technical efficiency of the poultry industry in Nepal. The study tried to fill that gap. The technical efficiency estimated would provide a new insight into the poultry industry in Nepal.

CHAPTER III
RESEARCH METHODOLOGY

3.1. RESEARCH DESIGN

The research intended to estimate the level of technical efficiency and its distribution spatially across the districts. The study was based on the quantitative data on the poultry farmer from report “Nepal commercial poultry Survey 2015”, published by central statistical bureau, Nepal (CBS, 2016). The research referred the various information from Ministry of agriculture, land management and cooperative, Nepal Rastra Bank, World Bank and other sources. The data were edit and processed using Excel and STATA-14.2 tools.

3.2. SOURCE OF DATA

The research relied on the secondary data collected on the commercial poultry farmer by Central Bureau of Statistic. Besides, various data from the Central Bureau of statistics, Ministry of Agriculture and Livestock Development, Nepal Poultry Federation, Nepal Rastra Bank, World Bank, Food and Agriculture Organization (FAO) etc. were referred for the research purpose.

3.3. DATA PROCESSING

The secondary data from the report “Nepal Commercial Poultry Survey 2015” prepared by CBS (2016) were processed for its analysis. Ms.Excel was utilized for processing the data.

In the report, all of the data were explained in the total sum per observed district. The data was process to obtain mean value of each observed district for further analysis. The current expenditure was further divided into the feeding cost, medicine cost, salary and other cost.

The report explained the temporary labor in the maydays. But, the permanent workers were accounted in numbers of labor. As per the labor act, 1992 each worker is allowed to work for 8 hrs per day . Working 8 hrs a days is considered as the one Mandays work. Considering, there is 52 public holidays including Saturdays, each permanent labor worked for 285 maydays. So, total labor per district was calculate in the mandays. Similarly, mean number of labor employed per district was estimated for further analysis.

Lastly the natural logarithum value of each observation were calculated for further analysis.

3.4.VARIABLES SPECIFICATION

The data was obtained from the CBS report about the commercial poultry farming in Nepal 2015. The research done by CBS showed the farmer in 64 district out of 75 were engaged in commercial farming.

For the study, the total revenue received from the meat and egg received was considered as the dependent variable. The independent variables were categorized as follows,

1) total stock of bird during the period of the research,
2) total man-days labor engage in work which includes both family and hired workers in permanent or temporary basis and
3) feeding cost for the chicken.

Before the medicinal cost and other various recurrent cost were also considered as the independent variable for production function. However, we reasoned the p-value of 0.1 as a critical threshold. Any independent variable with p-value above 0.1 were considered insignificant for the production model. The study found the both medicinal and other variable cost p–value were a lot higher. These two variable were not included in the production model. The analysis was done with the help of STATA program.

3.5. SPECIFICATION OF THE MODEL

The study considered each district as a unit of analysis. The Cobb-Douglas production model was used to define the stochastic production function of the study. The production model was:

$$\ln Y_i = \beta_0 + \beta_1 \ln L_i + \beta_2 \ln S_i + \beta_3 \ln F_i + \beta_4 \mathrm{Ln} M_i + \beta_5 \mathrm{Ln} V_i + v_i - u_{i,}$$

After the stepwise regression the $\mathrm{Ln}M_i$ and $\ln V_i$ p-value were higher than the 0.1. The production model for stochastic frontier analysis was,

$$\mathrm{Ln}Y_i = \beta_0 + \beta_1 \mathrm{Ln}L_i + \beta_2 \mathrm{Ln}S_i + \beta_3 \mathrm{Ln}F_i + v_i - u_i \quad \_\_\_\_\_\_\_\_ \ (7)$$

Here, $\mathrm{Ln}Y_i$ = Logarithm of the average revenue received from production of meat and egg in a district i.

$\mathrm{Ln}L_i$ = Logarithm of the average mandays labors engage in work in a district i.

$\mathrm{Ln}S_i$ = Logarithm of the average stock of bird during the period of research (2014/2015) in a district i.

$\mathrm{Ln}F_i$= Logarithm of the average expenses for feeding in a district i.

$\mathrm{Ln}M_i$ = Logarithm of the average medical cost in a district i.

$\mathrm{Ln}V_i$ = Logarithm of average variable cost in a district i.

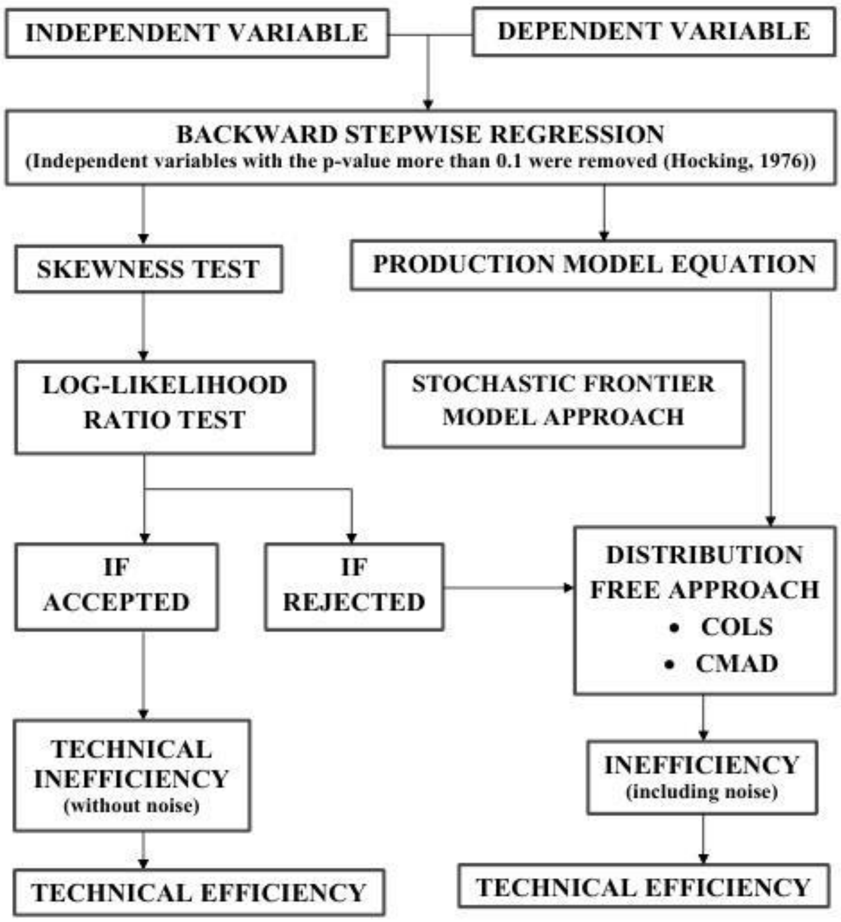
V_i= Random systematic error that is believed to be out of control of the owner

U_i = one sided error that show the technical inefficiency.

3.6. CONCEPTUAL FRAMEWORK

Processing helped to separate the data into the dependent variable and number of independent variables. But not all the independent variables were statistically significant in analysis. Backward stepwise regression method helped to drop out unnecessary variables. If the p-value were higher than 0.1, independent variable would be statistically insignificant and removed from the regression (Hocking, 1976). Afterward, required parameter were calculated using the maximum likelihood method. Here, the computation followed the instruction stated in the book "A practitioner's Guide to Stochastic Frontier Analysis using Stata" co-authored by Kumbhkar, Wang, & Horncastle (2015). The process was heavily simplified using the STATA tool. Both Kumbhkar, Wang, & Horncastle (2015) and Belotti, Daidone, Ilardi, & Atella (2013) were refered for the process. The step by step process of the research is shown in the figure below.

FIGURE 1: FLOWCHART SHOWING THE CONCEPTUAL FRAMEWORK OF THE RESEARCH



source: Kumbhkar et al., (2015)

CHAPTER IV
DATA ANALYSIS AND RESULT

4.1. DESCRIPTIONS OF THE VARIABLES

The research was analyze using the computer software STATA 14.2. Besides STATA, histogram, bar-diagram, graph and table were applied for analysis. The table below summary statistic of the variable in the production model.

TABLE 1: DESCRIPTIONS OF THE VARIABLES

Symbol	Parameter β (Std. Dev)	P-value	Mean (Std. Dev.)
LnY	-	-	13.75699 (0.4685359)
β_0	2.4918 (0.9717) *	0.013	-
LnL	0.3766 (0.1644) *	0.026	6.570839 (0.1562968)
LnS	0.2933 (0.1028) **	0.006	7.65835 (0.4911227)
LnF	0.4958 (0.0952) ***	0.000	13.19752 (0.539496)
LnM	0.5478	>0.1	10.23628 (0.7061127)
LnV	0.2404	>0.1	10.97469 (0.6502027)

*= P ≤ 0.05= statistically significant,
** = P ≤ 0.01=statistically moderately significant,
*** = P ≤ 0.001=statistically highly significant

Source: Author's calculation using NCPS 2015

At first, backward stepwise regression was used to remove the insignificant variables. Any variable with the p-value more than 0.1 were consider insignificant for the production model (Kodde & Palm, 1986). The model showed the variables labor and stock of birds are statistically significant for the model. The variable feed cost is statistically highly significant for the model. The variables for medicinal cost and other various recurrent expenditure were insignificant and not considered in further analysis. The regression showed the R2 value of 0.8784 and adjusted R2 value of 0.8723. It showed that about 87 percent of the variation in the dependent variable is explained by the independent variables.

The OLS regression technique provides the consistent slope parameter but biased constant. The residual from the OLS can be used to determine the skewness in the production model. Later, the coefficients of the slope parameter were used as initial value for stochastic production frontier analysis. The log-likelihood value obtained from the OLS was 25.631.

4.2 FINDING ON THE HYPOTHESIS TESTING

The study assumed the null hypothesis without any technical inefficiency (i.e. H_0: u_i=0). One of the ways to test the hypothesis was to estimate its skewness. The production model with technical inefficiency should have negative skewness. Skewness calculated using estimated residual using the STATA obtained following value.

TABLE 2: SKEWNESS TEST

Variable	Observation	Mean	Standard deviation	Variance	skewness	P-value
e	64	3.35e-10	0.1634	0.0267	-0.2972	0.2957

Source: Author's calculation using NCPS 2015

In the above table, variable e represent the residual obtained with OLS regression. The skewness test showed the presence of negative skewness of -0.2972. It showed the presence of the inefficiency in the production model. However, the p-value was 0.2957, which was higher than the recommended level of 0.05. The test failed to confirm the presence of technical inefficiency.

The OLS regression did not consider the assumption made about the distribution. The log-likelihood ratio test considered the distribution assumption and more precise to specific model. The log-likelihood test depends on the log-likelihood values of the restricted model (OLS) and unrestricted model (Stochastic Frontier Model). The formula for the log likelihood test is as follows:

$$LR = -2[L(H_0) - L(H_1)]$$

TABLE 3. LOG-LIKELIHOOD RATIO TEST

	OLS	Stochastic Frontier Model (SFM)	
		Half-Normal distribution	Exponential distribution
Degree of Freedom		1	1
Log-likelihood value	25.63	26.198	27.2311
Log-likelihood ratio (LR)	-	1.14	3.20

Source: Author's calculation using NCPS 2015

The value obtained from the above equation was compare with the mixed chi-squared table given by Kodde & Palm (1986) for the 1 degree of freedom (dof). The mixed chi-squared table is given in Appendix 1.

In the above table, the log-likelihood value of SFM with exponential distribution is 27.2311 which is higher than the SFM with half-normal distribution of 26.198. The LR test prefer the exponential distribution over half-normal (Kumbhkar et al., 2015). The Log-likelihood ratio of half-normal distribution was lower than the tabulated value in the mixed chi-squared table. In this case, we failed to reject the null hypothesis. However, in case of the exponential distribution, the log-likelihood values were higher than the tabulated value. The obtained value for exponential distribution was 3.2 whereas the tabulated value is 2.706 for degree of freedom of 1 and level significance of 5%. In this case, we rejected the null hypothesis. It showed the presence of the technical inefficiency in the production model.

4.3. FINDING ON STOCHASTIC FRONTIER MODEL

4.3.1. ESTIMATION OF THE PARAMETERS AND TECHNICAL EFFICIENCY

The Log-likelihood ratio test showed the production model with exponential distribution rejected the null hypothesis of no inefficiency. The table below give a statistical summary of estimated using the stochastic frontier model with exponential distribution.

TABLE 4: STOCHASTIC FRONTIER MODEL WITH EXPONENTIAL DISTRIBUTION.

LnY Frontier	Parameter (β)	Coefficient	Std. Error	P>|Z|	Confidence Interval (95%)
	β_0	1.5555	0.9333	0.096	(-0.2738) – 3.3848
lnL	β_1	0.5167***	0.1522	0.001	0.2184 – 0.8151
LnS	β_2	0.2463**	0.0918	0.007	0.0665 – 0.4262
LnF	β3	0.5320***	0.0822	0.000	0.3709 – 0.6932
U(cons)	-	-4.5537***	0.5766	0.000	(-5.6839) – (- 3.4237)
V(cons)	-	-4.1841***	0.2956	0.000	(-4.7636) – (-3.6047)
Sigma_u (σ_u)	-	0.1026	0.0296	0.001	0.5831 – 0.1805
Sigma_v (σ_v)	-	0.123	0.0183	0.000	0.9238 – 0.1649
*= P ≤ 0.05= statistically significant, ** = P ≤ 0.01=statistically moderately significant, *** = P ≤ 0.001=statistically highly significant					

Source: Author's calculation using NCPS 2015

The coefficient of all the independent variables was positive. It showed the proportional relation between the dependent and independent variables. The feed cost and labor independent variables had the p-value of less than or equal to 0.001. they were statistically highly significant for the model. The Stock of bird variable had p-value of less than 0.01. It is statistically moderately significant for the model. The Study done by other researcher like Ezeh, et al., (2012), Ohajianya, et al., (2013) and Ullah, et al., (2019) showed the variables like feed cost, labor and stock size were significant at 1%.

The feed cost had the highest coefficient value of 0.53. The 100 rupees increase in the feed increase the total output by 53 rupees. The CBS (2016) report also stated that the chicken feed cost occupied the largest percent of the recurrent expenditure. It occupy 67 percent of the recurrent expenditure. The study done by the Osti et al.,(2016) also found the similar conclusion. The feed cost occupy the 74.03% of the total variable cost. Similarly, 1 percent increase in labor or stock of chicken increase the value of output by 0.52 percent and 0.25 percent respectively.

Technical inefficiency was estimated using the method purposed by Jondrow et al., (1982). The point estimate for each observation were estimated using the condition mean of u_i given ε_i [E($\frac{u_i}{\varepsilon_i}$)]. Technical inefficiency determined were subsequently utilized to estimate the technical efficiency [Exp{-E$\left(\frac{u_i}{\varepsilon_i}\right)$}].

TABLE 5: TECHNICAL INEFFICIENCY AND EFFICIENCY

Variable	Observation	Mean	Std. dev	Min	Max
U	64	0.1026	0.0806	0.0287	0.5177
U_LB95	64	0.0119	0.0418	0.0007	0.2758
U_UB95	64	0.2652	0.1132	0.1016	0.7596
Eff	64	0.9051	0.0640	0.5958	0.9716
Eff_LB95	64	0.7715	0.0782	0.4678	0.9033
Eff_UB95	64	0.9889	0.037	0.7589	0.9992

Source: Author’s calculation using NCPS 2015

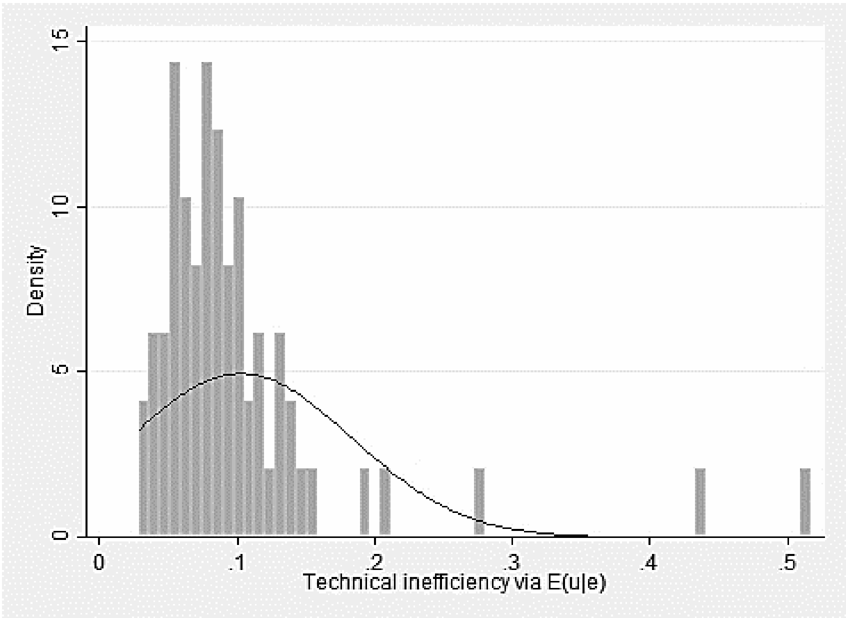
Here, U show the technical inefficiency, U_LB95 show the lower bound of 95 per cent confidence interval and U_UB95 show the upper bound of 95 per cent confidence interval, EfF show the technical efficiency and Eff_LB95 and Eff_UB95 showed the lower and upper bound in 95 per cent confidence interval.

The above table showed the average technical ineffciency of 10.26 per cent. The minimum technical inefficiency is 2.87 percent and maximum technical inefficiency is 51.77 percent. Similarly the technical efficiency was 90.51 per cent. Its maximum technical efficiency is 97.16 percent and minimum is 59.58 percent. It showed that in an average the poultry firm produced about 90 percent of the maximum output. It also showed the technical efficiency could be reduced by 10.26 per cent and similarly the technical efficiency could be improved by 9.49 per cent. The difference between the two value is due to the fact that $1-e^{u}$~u. U value is very small therefore there is little different between the both reading.

4.3.2. DISTRIBUTION OF TECHNICAL EFFICIENCY ACROSS THE DISTRICTS.

The distribution of the technical efficiency could be determined by estimating the variance. variance of technical inefficiency(σ_u^2) is equal to exp(u_sigma) = 0.01053 . The small variance increase the probability of the observation being close to 100 per cent efficient. It could further explained through the histogram below.

FIGURE 2 : HISTOGRAM SHOWING THE DISTRIBUTION OF TECHNICAL INEFFICIENCY



Source: Author's calculation using NCPS 2015

The above graph showed the distribution of the technical inefficiency. Except for the few observations, most of the observation were concentrate near to the point 0.1. The Tail are of the distribution was very small. It showed that technical efficiency of the commercial poultry firm in each district was relatively high.

TABLE 6: FREQUENCY OF DISTRIBUTION OF TECHNICAL EFFICIENCY.

Efficiency(%)	Frequency	Percent
95 and above	8	0.13
95-90	38	0.59
90-85	13	0.20
85-80	2	0.03
80-75	1	0.016
75 and below	2	0.03

Source: Author's calculation using NCPS 2015

The study showed the 46 out of 64 observation had the efficiency equal and above the 90 percent. The above table showed the technical efficiency of 51 districts lies between 95 and 85 percent and 8 district had the technical efficiency of above 95%. It showed the near homogenous distribution of the technical efficiency across the sampled district.

TABLE 7: DISTRIBUTION OF THE TECCHNICAL EFFICIENCY IN PERCENTILES.

Percentiles	Technical Efficiency
1%	0.5958
5%	0.811
10%	0.8659
25%	0.8944
50%	0.9182
75%	0.941
90%	0.9591
95%	0.9591
99%	0.9716

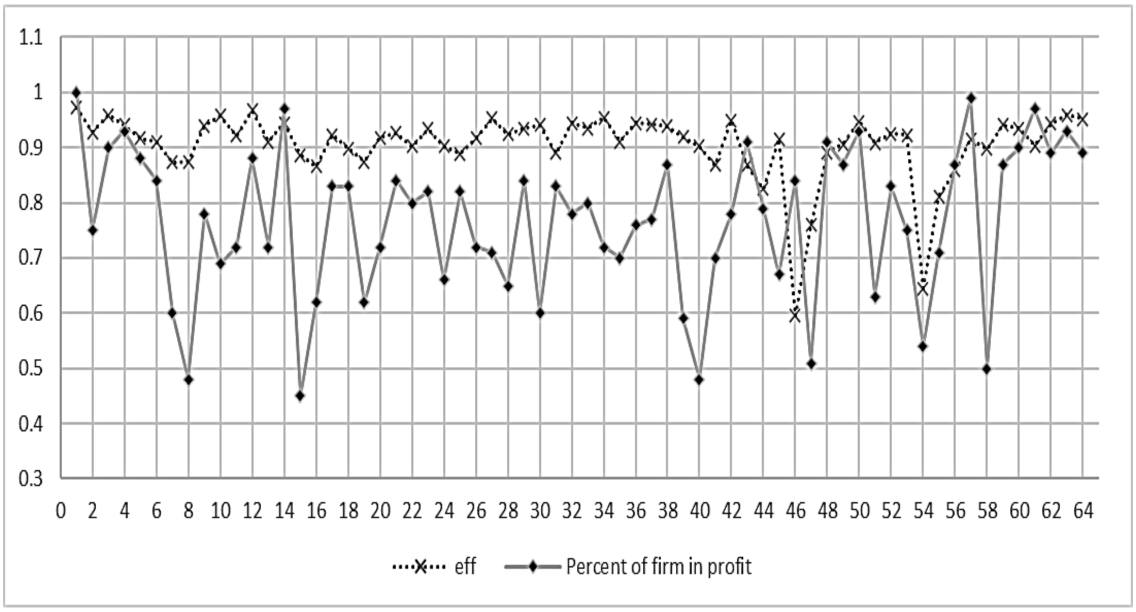
Source: Author's calculation using NCPS 2015

The above table show the distribution of the technical efficiency through the percentiles. Average technical efficiency was 90.51 per cent . The above table showed that at 25th percentiles Technical efficiency is 89.44 percent. It showed 75 per cent of the observation lies around and above the average technical efficiency. At 10th percentile, the technical efficiency showed 86.59 per cent which is very close to the 90.51 percent. The above distribution show the near homogenous distribution of the technical efficiency across the observation. There were few outliner for example Rupandehi and Banke with 59.58 per cent and 64.47 per cent of technical efficiency respectively.

4.3.3. EFFECT OF THE TECHNICAL EFFICIENCY ON PROFIT

Profit is the benchmark for any business. Margin of profit determines the sustenance and expansion of the business. Efficient operation of the farm help to decreased the cost of operation and increased the margin of profit. CBS (2016) stated that 76% of poultry farms were running in profit. The graph below referred the data about the percent of farm running in profit in a district from CBS (2016) and sketched the comparative graph against the technical efficiency of the corresponding district.

FIGURE 3: COMPARATIVE GRAPH OF TECHNICAL EFFICIENCY AND PERCENT OF FIRMS RUNNING IN PROFIT.



Source: Author’s calculation using NCPS 2015

The mean percent of the firm running in profit was 76%. At 90% efficiency, 24% of the firm were running in less than desirable result (CBS, 2016). District with higher efficiency had the higher percent of firm running in profit. But it does not guarantee the higher margin of profit. Some of the districts like Myagdi, Siraha, Terhathum, Bajhang had the technical efficiency around and above 90 per cent but only 50 percent of the firm were running in profit. In other districts like Kapilbastu and Banke, 50 percent of the firm were running in profit. Their average technical efficiency were 75 percent and 64 percent respectively. The graph clearly showed there were other factor that effect the profit level in the firm.

Technical inefficiency is one of the two-error term. Random shocks like weather and climatic condition, unfavorable market, disease, natural calamities could influence cost of production and reduced the profit margin. Simple calculation of variance ratio ($\frac{\sigma_u^2}{\sigma_v^2+\sigma_u^2}$) showed that only 41.24 percent of the compound error could be explained by the technical ineffficiency.

Rupandehi was interesting case in this matter. It was outlier among the observations. The data clearly showed that 84 percent of the firm were running in profit but the estimated technical efficiency is only 59 percent and 74 percent of the farmer received the training for poultry farming (CBS, 2016).

CHAPTER V
SUMMARY AND CONCLUSION

5.1. SUMMARY

The estimated technical efficiency is 90.51 percent. It showed that in an average the poultry firm produced about 90.5 percent of the maximum output. It could be further improved by 9.5 percent. However, the technical inefficiency estimated is 10.26. There is a minor difference between the both values because ($1-e^{u}$) is about equal to u. The difference is very small and negligible. Since value to u is small, the difference is also very small.

The parameters estimated from SFA method were positive and statistically significant for the model. Feed cost and labor had the highest coefficient values among parameters. Osti et al., (2016) stated the Nepal poultry industry is partially depend on external sources form feed raw materials,feed addative, antibiotic etc. The article also separate the feed cost as the main factor affecting the cost of production of chicken meat and eggs. CBS (2015) also stated that 67% of recurrent expenditure were expend on feed suppliments. Both report did not express any concern over availability of the feed suppliments however, highlighted the importance of the price and quality of the feed cost in raising the poultry.

CBS report (2016) clearly state that the nearly 80 percent of the owner are educated up to SLC level. Nearly 70 percent of the firm owner fall between the age group of (25-44). It meant the large number of the farmer were young and educated. The young educated could easily grasped the new technology. They are familiar with new digital communication technology improving the access to market, resources and new information relate to the poultry farming. The large number of the labor were unpaid labor. It meant most of the labor working in the poultry farm are family member. They run the poultry farm as the family business. Therefore, they have sense of responsibility and ownership and less likely to be negligence. They also have better communication and flexible working period. They could easily accommodate each other in case of emergency, openly communicate about the difficulties, and provide necessary guidance or solution. These factors helped to run the poultry industry at high efficiency.

The technical efficiency estimated spatially across the districts showed the near homogenous distribution of the technical efficiency. The variance of technical inefficiency was 0.01053, which is very small. Small variance increases the probability of the firm running in full efficiency. "Figure 2: Histogram showing the distribution of technical inefficiency" clearly show the concentration of the observation near 0.1 technical inefficiency. However, "Figure 3: Comparative graph of technical efficiency & percent of firm running in profit" showed the higher technical efficiency does not guarantee the higher revenue and profit. Because, the technical efficiency is estimated through compound error. It is one of the two part of the compound error. Other part i.e. random shock can affect the daily operation of the firm. The poultry farmer and government need to look at the external factor and search for the combine solution that effect the district. However, some district had low technical efficiency and low percent of the firm running in profit. In that case, the better managerial behavior could increase efficiency and output. Separate specific studied should be done to understand the abnormality of the outlier district.

5.2. CONCLUSION

The study clearly rejects the null hypothesis of no technical inefficiency. The stochastic production frontier model with exponential disturbance is utilized to estimate the technical inefficiency. The study estimates the technical inefficiency at 10.26 percent and 90.5 percent of technical efficiency. Except for the few outliers like Rupandehi district, the study finds the homogenous distribution of the technical efficiencies across the district.

5.3. RECOMMENDATION

After estimating the technical efficiency and analyzing available data following recommendation are made to improve the poultry industry.

- Feed cost occupy the highest percent of the cost occurred in poultry farming. Beside this research other research done by Acharya & Kaphle (2015) and Osti et al., (2016) showed the importance of the feeds. The government need to bring forward the necessary plan and strategy to provide the high quality and enough quantities of Feed. Access to the feed should not become a bottle neck in future progress of the poultry farmer.
- Sufficient financial and technical support should be given to the farmer to expand and upgrade the poultry farm
- Outlier like Rupandehi district could be interesting subject for further study.

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APPENDICES

APPENDIX 1

MIXED CHI-SQUARED TABLE FOR ONE DEGREE OF FREEDOM.

α / dof	0.25	0.1	0.05	0.025	0.01	0.005	0.001
1	0.455	1.642	2.706	3.841	5.412	6.635	9.5

Source: Kodde & Palm (1986)

APPENDIX 2

TECHNICAL INEFFICIENCIES AND EFFICIENCIES

District	u	u_LB95	u_UB95	eff	eff_LB95	eff_UB95
Taplejung	0.028726	0.000765	0.10168	0.971683	0.903318	0.999236
Panchthar	0.074674	0.002494	0.22738	0.928046	0.796618	0.997509
Ilam	0.041275	0.001152	0.140858	0.959565	0.868613	0.998848
Jhapa	0.060998	0.001879	0.194804	0.940826	0.822996	0.998123
Morang	0.087177	0.003161	0.254296	0.916515	0.775462	0.996844
Sunsari	0.09346	0.003541	0.266933	0.910775	0.765725	0.996466
Dhankuta	0.135023	0.007086	0.339205	0.873696	0.712337	0.992939
Terhathum	0.133781	0.006947	0.337274	0.874782	0.713713	0.993077
Sankhuwasabha	0.062406	0.001937	0.198328	0.939501	0.820101	0.998065
Bhojpur	0.043701	0.001233	0.147983	0.957241	0.862446	0.998768
Okhaldhunga	0.081918	0.002867	0.243277	0.921347	0.784054	0.997137
Khotang	0.032711	0.000883	0.114538	0.967819	0.891778	0.999118
Udayapur	0.093958	0.003572	0.267912	0.910321	0.764975	0.996434
Saptari	0.05734	0.001731	0.185462	0.944273	0.830721	0.998271
Siraha	0.120688	0.005623	0.31617	0.886311	0.728935	0.994392
Dhanusa	0.143951	0.00816	0.352759	0.86593	0.702747	0.991873
Mahotari	0.079965	0.002763	0.239076	0.923149	0.787355	0.997241
Sarlahi	0.106883	0.004469	0.292226	0.898631	0.7466	0.995541
Sindhuli	0.133581	0.006925	0.336963	0.874956	0.713935	0.993099
Ramechhap	0.085702	0.003077	0.251247	0.917868	0.777831	0.996928
Dolakha	0.076583	0.002589	0.231653	0.926276	0.793221	0.997414
Sindhupalchok	0.103522	0.00422	0.286096	0.901656	0.75119	0.995789
Kavrepalanchok	0.068771	0.002216	0.213756	0.93354	0.807545	0.997787
Lalitpur	0.10307	0.004188	0.28526	0.902064	0.751819	0.995821
Bhaktapur	0.118047	0.005385	0.311734	0.888654	0.732176	0.99463
Kathmandu	0.087101	0.003157	0.254138	0.916585	0.775585	0.996848
Nuwakot	0.04768	0.001371	0.159364	0.953439	0.852686	0.99863
Rasuwa	0.078631	0.002694	0.236171	0.924381	0.789646	0.99731
Dhading	0.066985	0.002135	0.209507	0.935209	0.810984	0.997867
Makwanpur	0.061095	0.001883	0.19505	0.940734	0.822794	0.998119

District	u	u_LB95	u_UB95	eff	eff_LB95	eff_UB95
Rautahat	0.115746	0.005184	0.307815	0.890702	0.735051	0.994829
Bara	0.0575	0.001737	0.185877	0.944122	0.830376	0.998264
Parsa	0.067526	0.002159	0.210799	0.934704	0.809937	0.997843
Chitawan	0.046959	0.001345	0.157329	0.954127	0.854423	0.998656
Gorkha	0.093171	0.003522	0.266365	0.911037	0.76616	0.996484
Lamjung	0.056825	0.001711	0.184122	0.94476	0.831834	0.998291
Tanahu	0.059245	0.001807	0.190364	0.942476	0.826658	0.998195
Syangja	0.063221	0.001972	0.200349	0.938736	0.818445	0.99803
Kaski	0.084841	0.003028	0.249452	0.918658	0.779227	0.996977
Myagdi	0.103514	0.00422	0.28608	0.901664	0.751203	0.995789
Parbat	0.141628	0.007867	0.349285	0.867945	0.705192	0.992164
Baglung	0.052628	0.00155	0.172996	0.948733	0.841141	0.998451
Gulmi	0.14164	0.007869	0.349303	0.867934	0.70518	0.992162
Palpa	0.19212	0.017015	0.418152	0.825208	0.658262	0.983129
Nawalparasi	0.088049	0.003212	0.256082	0.915716	0.774078	0.996793
Rupandehi	0.517778	0.275881	0.759689	0.595843	0.467812	0.758903
Kapilbastu	0.27481	0.052613	0.512941	0.759717	0.598732	0.948748
Arghakhanchi	0.115445	0.005159	0.3073	0.890969	0.73543	0.994855
Pyuthan	0.099335	0.003926	0.278274	0.905439	0.75709	0.996082
Rolpa	0.05436	0.001616	0.177637	0.947091	0.837247	0.998386
Rukum	0.096516	0.003737	0.272888	0.907995	0.761178	0.99627
Salyan	0.077638	0.002643	0.23399	0.925299	0.79137	0.997361
Dang	0.080965	0.002816	0.241233	0.922226	0.785658	0.997188
Banke	0.438817	0.197199	0.680656	0.644799	0.506285	0.821027
Bardiya	0.20948	0.021943	0.439393	0.811006	0.644428	0.978296
Surkhet	0.152578	0.009337	0.365354	0.858492	0.693951	0.990707
Dailekh	0.088192	0.00322	0.256374	0.915585	0.773852	0.996785
Bajhang	0.107711	0.004532	0.293717	0.897888	0.745487	0.995478
Doti	0.060487	0.001858	0.193518	0.941306	0.824055	0.998144
Kailali	0.068031	0.002182	0.212003	0.934231	0.808962	0.99782
Kanchanpur	0.101832	0.004099	0.282963	0.903182	0.753548	0.995909
Dadeldhura	0.057961	0.001756	0.187068	0.943687	0.829388	0.998246
Baitadi	0.041744	0.001168	0.142246	0.959115	0.867408	0.998833
Darchula	0.04887	0.001413	0.162694	0.952305	0.849851	0.998588

Source: Author’s calculation using NCPS 2015

APPENDIX 3

STEPWISE REGRESSION

```
. stepwise, pr(0.1) : regress lny (lnl) (lns) (lnf) (lnm) (lnv)
                      begin with full model
p = 0.5478 >= 0.1000  removing lnm
p = 0.2404 >= 0.1000  removing lnv
```

Source	SS	df	MS		
Model	12.1480757	3	4.04935857	Number of obs =	64
Residual	1.6820537	60	.028034228	F(3, 60) =	144.44
Total	13.8301294	63	.219525864	Prob > F =	0.0000
				R-squared =	0.8784
				Adj R-squared =	0.8723
				Root MSE =	.16743

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnl	.3765944	.1644202	2.29	0.026	.0477051	.7054837
lns	.293316	.102772	2.85	0.006	.0877415	.4988905
lnf	.495876	.0952553	5.21	0.000	.3053369	.6864151
_cons	2.491795	.9717502	2.56	0.013	.5480051	4.435585

APPENDIX 4

STOCHASTIC FRONTIER ANALYSISS (EXPONENTIAL DISTRIBUTION)

```
Stoc. frontier normal/exponential model          Number of obs =         64
                                                 Wald chi2(3)  =     553.48
                                                 Prob > chi2   =     0.0000

Log likelihood =    27.2311
```

lny	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Frontier						
lnl	.5167725	.1522427	3.39	0.001	.2183823	.8151628
lns	.2463552	.0917654	2.68	0.007	.0664984	.4262121
lnf	.5320527	.0821998	6.47	0.000	.3709441	.6931614
_cons	1.555508	.9333412	1.67	0.096	-.2738068	3.384824
Usigma						
_cons	-4.553785	.5765925	-7.90	0.000	-5.683886	-3.423685
Vsigma						
_cons	-4.184169	.295644	-14.15	0.000	-4.763621	-3.604718
sigma_u	.1026025	.0295799	3.47	0.001	.0583123	.1805329
sigma_v	.1234296	.0182456	6.76	0.000	.0923832	.1649094
lambda	.8312638	.0418696	19.85	0.000	.7492008	.9133267