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# Application of Stochastic Frontier Model in Evaluating the Efficiency of Allowance related Public Safety Nets Programmes in Bangladesh

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**Abstract**

The stochastic frontier model is usually used in estimating the technical efficiency of production of firms. Several social safety nets programmes in Bangladesh are working to protect individuals living in vulnerable conditions. Using the primary data of 130 rural clusters covering 620 households for old age people, 327 for widows and 173 households for disables, this study attempts to apply the stochastic frontier model to evaluate the efficiency of three main allowance related public safety nets programmes considering two outcome variables, *viz*. food expenditure and healthcare expenditure. The *unconstrained trans-log production function was* found perfect *frontier model to evaluate the efficiency for both old age allowance and allowances for the widowed* for both the outcome variables. In addition, *Cobb-Douglas production function was appeared as ideal frontier model for allowances for disables* for both of the outcome variables. In addition, *technical inefficiency effect model* is found essential for evaluating the performance efficiency for most of the cases. The mean technical efficiency for *old age allowance, allowances for the widowed and allowances for disables were* estimated at 71.96%, 81.18% and 79.35% respectively for the outcome variable food expenditure, while the mean technical efficiency were estimated at 40.39%, 39.82% and 38.29%, respectively for the outcome variable healthcare expenditure. The findings of the study might be helpful for better design and implementation of the allowance related public safety nets programmes of Bangladesh since it explored the efficiency level and inefficiency determinants of the programmes.

**Keywords:** Stochastic production frontier model; Inefficiency effect model; Technical efficiency; Social safety nets programmes

## 1. Introduction

The government of Bangladesh has been implementing a number of social safety net programmes (SSNPs) with the intention to protect the people suffering from various types of adversity, which may occur due to landlessness, crop failure, old age vulnerability, unemployment, physical disability, widowhood vulnerability etc. Studies conducted on different aspects of social safety net programmes have focused on schemes, purposes, visions, outcomes, challenges, leakages, and successiveness [1-11]. However, some studies have been found to deal with the effect of a particular social safety nets programme on life and livelihood of beneficiary households with a limited coverage [1;8]. On the other hand, a few studies are found to deal with the review of the existing social safety net programmes and their importance on protection and poverty reduction [12-15]. The studies on productive outcomes and the program effectiveness bear mixed evidences in the context of Bangladesh[16].Comparing food and cash transfers to the ultra poor in Bangladesh,the IFPRI study has shown that the transfers from saftey net programmes in Bangladesh have been playing a crucial role in improving food security, protecing the poor housheolds from asset depletion [2].Using a very small-scale micro-level data, an attempt has been made to evaluate the impacts and implications for the old age allowance programme for selected beneficiaries and to identify the factors influencing the operations and performance of the program [8].The empirical evidence shows that the old age allowance programme had put positive impact on the food accessibility, both in quality and quantity, of the beneficiary households.

Using the primary qualitative data collected through FGDs and KIIs and analyzing the HIES-2010 data, a study has documented that the selected safety net programmes are promising means of protection and generate productive outcomes for the vulnerable

groups [6]. Despite strong evidences about the impacts of the safety nets programmes on beneficiary households' consumption as well as human/physical development outcomes [17- 18], evidences about their broader economic impacts are not explored appropriately[2]. In addition, the evaluation of the performance of the programmes with respect to the major outcome variables are completely absent in the existing literature. The applications of stochastic frontier models are not found to evaluate the effectiveness of any programmes, though it is generally practiced to evaluate the firm's efficiency on production/cost. This study has made an attempt to evaluate the performance efficiency of the allowance related public social safety net programmes implementing in Bangladesh with respect to the relevant outcome variables by employing the stochastic frontier

## 2. Methodology

### 2.1 Data Sources

The study collected primary data through a research project "Targeting Effectiveness and Productive Outcomes of the Social Safety Net Programmes in Rural Bangladesh: An Evaluation", sponsored by the Ministry of Education, Government of Bangladesh [16]. The study had used cluster-sampling technique and the primary sampling units (PSUs) of Bangladesh Bureau of Statistics (BBS) were considered as clusters. The village mapping through PRA was used to identify the targeted units of analysis in the selected clusters.The required data had been collected from 130 rural clusters covering at least 30 clusters from each of the four old divisions (Dhaka, Chittagong, Rajshahi and Khulna) of Bangladesh.The analysis for this study had been performed by beneficiary households covering 620 for old-age allowances, 327 for widowed allowances and 173 for disableallowances.The performance efficiency of these safety nets programmes had been evaluated through stochastic frontier analysisconsidering the outcome variable food expenditure (as a proxy of poverty or food insecurity) and health care expenditure.

### 2.2 Model Specification

The study applied both Cobb-Douglas and Trans-log functions as stochastic frontier model, which are expressed as

$$\ln y_i = \beta_0 + \sum_{j=1}^{n} \beta_j \ln X_j + V_i - U_i \quad \text{..... (1)}$$

$$\ln y_i = \ln\beta_0 + \sum_{j=1}^{n} \beta_j \ln X_j + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \beta_{jk} \ln X_j \ln X_k + V_i - U_i \quad \text{..... (2)}$$

Where, $Y_i$ represent the output of the i-th safety net programmes, $X_i$ is a vector of input quantities, $b_i$ is a vector of unknown parameters. $n_i$ is distributed as NID $(0,s_n^2)$ and independent of $U_i$. The $U_i$ represents technical inefficiencies in output and are assumed to be distributed as NID $(m,s_n^2)$ with truncation at zero. The relationship between $U_i$ and the output-oriented technical efficiency is TE= exp(-$U_i$)

The technical inefficiency effect model proposed by Battese and Coelli [19] had been used in the stochastic

$$U_i = \delta_0 + \sum Z_i\delta_j + W_i \quad \text{..... (3)}$$

where, $Z_i$ is a vector of explanatory variables which may influence the inefficiency of safety net programmes and d is a vector of parameters to be estimated. The random variable $W_i$ follows normal distribution with mean zero and variance $s^2$. Finally, the technical efficiency of the i-th safety net programme can be expressed by $TE_i$ =exp (-$U_i$).The maximum likelihood method was used to estimate the unknown parameters of the models.

### 2.3 Tests for Functional Form and Necessity of Inefficiency Effect Model

For identifying the functional form of the stochastic performance frontier, statistical test based on generalized likelihood ratio was conducted considering two types of function - homothetic (Cobb-Douglas) and non-homothetic (Trans-log). The null hypothesis is that the performance of selected SSNPs exhibited Cobb-Douglas type of production function, i.e. all the effects of square and interaction terms in the trans-log function are zero ($H_0$: $b_{ij} = 0$; i, j = 1, 2, …, n). The b and d-coefficients were estimated together with the variance parameters which were expressed in terms of $s^2 = s_u^2/s_v^2$ and $g = s_u^2/s^2$, where g parameter has a value between zero and one. The test statistic is $l= -2 [\ln(L_c) - \ln(L_t)] \sim c^2_{(0.05)}$ (j), where $\ln(L_c)$ and $\ln(L_t)$ denoted the log likelihood value of the Cobb-Douglas and Trans-log models respectively and J stands for degrees of freedom. Another test based on generalized likelihood ratio had also performed to check whether the trans-log stochastic frontier model had constant returns to scale. The study performed the tests of three hypotheses to identify the suitability of technical inefficiency effect model following Battese and Coelli [18]. These are: (i) Beneficiary households were completely efficient for targeted outcome variable, i.e. inefficiency effect model was dropped from the production function ($H_0$: $g = d_0 = d_1 =...= d_j = 0$); (ii) the inefficiency effects are not stochastic ($H_0$: $g = 0$; indicates $s_u^2 = 0$ and $d_0$ are equal to zero), and (iii) the inefficiency effects are not a linear function of the covariates ($H_0$: $g = d_1 =...= d_j = 0$), where j represents the number of variables included in the inefficiency effect model. The generalized likelihood ratio along with Wald test statistic had been used to test

## 3. Results and Discussions

The stochastic frontier model (1 and 2) considers the independent variables - family size, years of schooling of household head, land size, SSNP income, asset score,

dependency ratio and donation received. In addition, female headship, income regularity status, poverty score, food security status, and currently working status were considered as covariates for technical inefficiency effect model (3).

The required tests of the functional form of the production frontier and necessity of *Technical inefficiency effect model* for the outcome variables food expenditure and health care expenditure of the three selected safety nets programmes are shown in Appendix Table 1. The estimates of the parameters of the *Trans-log stochastic model* for *old age allowance* and *allowances for widowed* with the outcome variables food expenditure and health care expenditure are given in Appendix Table 2. The estimates of the parameters of the *Cobb-Douglas production frontier model* for the outcome variable food expenditure and health care expenditure for *allowance for the disables* are shown in Appendix Table 3. The overview of the estimated performance efficiency along with functional form of frontier model and the necessity of the inefficiency effect model of the selected safety nets programmes with respect to the targeted outcome variables are shown in Table 1.The results for each of the three safety nets programmes are categorically discussed below.

### 3.1 *Old Age Allowance*

The findings indicated that the *unconstrained trans-log stochastic production frontier model* was an ideal choice to evaluate the performance efficiency for *old age allowance programme* for both of the outcome variables, food expenditure and healthcare expenditure (Appendix Table 1). The generalized likelihood-ratio test confirmed that *Technical inefficiency effect model* was essential for evaluating the performance efficiency of *old age allowance* with the outcome variables food expenditure and health care expenditure.The estimates of the parameters of the Trans-log stochastic model for *old age allowance* with the outcome variables food expenditure indicated that family size, SSNP income and dependency ratio have had significant positive impact on the food expenditure (Appendix Table 2). The findings indicated that the food expenditure of the beneficiary households will be increased significantly with the increase of family size, SSNP income and dependency ratio. However, education of the household head, land size, asset score and donation received were found insignificant. The squared terms of all the independent variables except dependency ratio were found significant positive impact on the response variable.The estimate for the variance parameter ($\gamma$) was close to one, indicated that the inefficiency effects were likely to be highly significant for the output of the households. The estimate of the parameters of the inefficiency model indicated that female headship, income regularity status, food security status and currently working status had significant effects upon the inefficiency of food expenditure for old age allowances (Appendix Table 2). Among these significant covariates, the effect of income regularity status was found negative. This means that inefficiency effects decreases with the increase in income regularity status. That is, the technical efficiency would be increased with the increase of regular income sources. The poverty score appears to have no significant effect upon the inefficiency of food expenditure. The mean technical efficiency for *old age allowance* with the outcome variable food expenditure was estimated at 71.96%, indicating that there was an ample scope to increase the efficiency of the old age allowance programme by addressing the inefficiency coefficients found in the study.

For the response variable 'health care expenditure', the estimated parameters of the Trans-log stochastic production frontier model indicated that family size and SSNP income had significant impact (Appendix Table 2). However, education of the household head, land size, asset score, dependency ratio and donation received were found insignificant. The impact of SSNP income on health care expenditure was found negative, may be because of most of the poor households received SSNP benefits and they hardly spent the SSNP income for health care purposes.

This reality confirmed by the result of significant positive impact of the interaction between SSNP income and asset score. That is, households with higher asset score spent their SSNP income for health care expenditure. The estimates of the parameters of the inefficiency model indicated that all the variables (female headship of the household, income regularity status, poverty score, food security status and currently working status) had significant effects upon the inefficiency of health care expenditure (Appendix Table 2). Among these significant covariates, the effect of female headship, poverty score and food security status were found negative. This means that inefficiency effects will be decreased with the increase in female headship status, poverty score and food security status. That is, the technical efficiency for health care expenditure would be increased with the increase of female headship status, food security status and poverty score. On the other hand, the coefficient of income regularity status and currently working status was found positive in technical inefficiency effect model, indicating that inefficiency effects increases with the increase of both the covariates.The mean technical efficiency for the outcome variable health care expenditure was estimated at 40.39% indicating that there was a huge scope to increase the efficiency of the programmeby addressing the inefficiency coefficients found in the study.

### 3.2 *Allowances for the Widowed, Destitute & Deserted Women*

The findings specify that the *unconstrained trans-log stochastic production frontier model should* be used to

**Table 1: Overview of the performance efficiency of the selected safety nets programmes**

| Selected SSNP Programme | Outcome Variable | Functional form of the production frontier | Efficiency (%) | Comment on inefficiency effect model |
|---|---|---|---|---|
| Old age allowance | Food Expenditure | Unconstrained trans - log stochastic frontier model | 71.96 | Technical inefficiency effect model is essential |
| | Health Care Expenditure | Unconstrained trans - log stochastic frontier model | 40.39 | Technical inefficiency effect model is essential |
| Allowances for the widowed | Food Expenditure | Unconstrained trans - log stochastic frontier model | 81.18 | Technical inefficiency effect model is essential |
| | Health Care | Unconstrained trans - log stochastic frontier model | 39.82 | Technical inefficiency effect model is essential |
| Allowances for Disabled | Food Expenditure | Cobb - Douglas production frontier Model | 79.35 | Technical inefficiency effect model is essential |
| | Health Care | Cobb - Douglas production frontier Model | 38.29 | Technical inefficiency effect model is essential |

evaluate the performance efficiency for *allowances for the widowed* for both of the outcome variables (Appendix table 1). In addition, the value of variance parameter (g) confirmed the *necessity of technical inefficiency effect model*. The education of the household head and asset score were found to have significant impact on the response variable (food expenditure) in the estimated Trans-log stochastic production frontier model. However, effect of education of the household head is negative, indicating that food expenditure of the vulnerable households decreases with the increase of the education of the household heads.

The estimates of the parameters of the inefficiency model indicated that female headship of the household and income regularity status have put significant positive effects upon the inefficiency of food expenditure for *allowances for the widowed* (Appendix Table 2). This means that inefficiency effects increases with the increase of female headship and income regularity status. That is, the technical efficiency of *allowances for the widowed* with respect to the food expenditure would be decreased with the increase the level of these two variables. The mean technical efficiency for *allowances for the widowed* with the outcome variable food expenditure is estimated at 81.18% indicating that about 19% inefficiencies are occurred due to impact of several covariates of inefficiency effect model.

While considering the outcome variable 'health care expenditure' for *allowances for the widowed*, the estimates of all the parameters of the Trans-log stochastic production frontier model were found significant (Appendix Table 2). Among the independent variables, family size and SSNP income were found to have significant negative effect upon the response variable (health care expenditure) of the Trans-log stochastic production frontier model. The estimates of the parameters of the inefficiency model for *allowances for the widowed*, indicates that all the covariates except poverty score have significant positive effect upon the inefficiency of health care expenditure. This means that inefficiency effects would be increased significantly with the increase the value of these covariates. The mean technical efficiency for *allowances for the widowed* with the outcome variable health care expenditure is estimated at 39.82% indicating that there is ample scope to increase the efficiency of the programmes with respect to health care expenditure by taking care of the inefficiency coefficients found in the study.

### 3.3 *Allowances for Disables*

The results of tests of hypotheses regarding the functional form of the production frontier indicated that the *Cobb-Douglas production frontier model* would be an ideal choice to evaluate the performance efficiency of *allowances for disables* for both of the outcome variables (Appendix Table 1). In addition, the results of tests of hypotheses of the parameters of the technical inefficiency effect model confirmed that *Technical inefficiency effect model* was not essential for evaluating the performance efficiency of *allowances for disables* for the outcome variable food expenditure. However, the *Technical inefficiency effect model* was essential for evaluating the performance efficiency of *allowances for disables* for the outcome variable health care expenditure. The estimates of the parameters of the model indicated that family size; land size and asset score have had significant impact on food expenditure (Appendix Table 3). However, effect of land size of the

household was found negative, indicating that food expenditure of the households decreases with the increase of the land size of the households. The mean technical efficiency for *allowances for disables* with the outcome variable food expenditure is estimated at 79.35%.

For the outcome variable 'health care expenditure', the estimates of the covariates family size, SSNP income and donation received of the *Cobb-Douglas production frontier* model were found have significant positive impact (Appendix Table 3). The estimates of the parameters of the inefficiency model for *allowances for the disables* indicated that all the covariates have significant positive effect upon the inefficiency of health care expenditure. Among these covariates, income regularity status and food security status were found negative. This means that inefficiency effects would be increased significantly with the decrease the value of these two covariates. The mean technical efficiency for *allowances for disables* with the outcome variable health care expenditure is estimated at 38.29% indicating that there is ample scope to increase the efficiency of the programmes with respect to health care expenditure by taking care of the inefficiency coefficients found in the study.

## 4. Conclusion

The performance efficiency of allowance related safety nets programmes have been evaluated by employing stochastic frontier analysis with Cobb-Douglas and Trans-log (restricted and unrestricted) functional form. After performing the required tests of hypotheses, the findings indicated that the *unconstrained trans-log stochastic production frontier model* appeared the appropriate model to evaluate the performance efficiency for old age *allowance and allowances for widowed* for the outcome variables food expenditure and health care expenditure. The Cobb-Douglas model was found suitable to evaluate the performance efficiency for allowances for disables. In addition, *technical inefficiency effect model* was found essential for evaluating the performance efficiencyfor most of the cases.

The mean technical efficiency was found reasonably higher for the outcome variable food expenditure in comparison to healthcare expenditure. In addition, the necessity of inefficiency effect model indicates that the programmes were not fully efficient for ensuring food security and healthcare of the beneficiaries.The poor performance efficiency for healthcare expenditure indirectly indicated that the program support was not sufficient for ensuring food security and henceforth there was a very little scope for spending on healthcare. Therefore, the study recommended to increase the allowances of the particular safety nets programmes, so that the beneficiaries can come out from poverty within stipulated time schedule in order to achieve different development goals of the GoB, particularly the Seventh Five-Year Plan and Sustainable Development Goals.

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**Appendix Table 1: Testing the functional form of the production frontier and technical inefficiency effect model for the outcome variables food expenditure and health care expenditure for *Old Age Allowance, Allowance for Widowed andAllowance for Disables***

| | Null Hypothesis | DF | Critical value | Food Expenditure | | Health Care Expenditure | |
|---|---|---|---|---|---|---|---|
| | | | | λ* | Inference | λ* | Inference |
| Old age allowance | **Testing the functional form of the production frontier** | | | | | | |
| | $H_0$: The production frontier is Cobb-Douglas form | 28 | 41.34 | 86.04 | Reject $H_0$ | 54.68 | Reject $H_0$ |
| | $H_0$: The trans-log stochastic frontier model exhibits constant returns to scale. | 5 | 11.05 | 59.38 | Reject $H_0$ | 30.14 | Reject $H_0$ |
| | **Tests of hypotheses on the parameters of the technical inefficiency effect model** | | | | | | |
| | $H_0$: $\gamma=\delta_0=\delta_1=\ldots=\delta_5=0$ | 8 | 15.51 | 213.2 | Reject $H_0$ | 236.48 | Reject $H_0$ |
| | $H_0$: $\gamma=0$** | 3 | 7.81 | 208.2 | Reject $H_0$ | 206.92 | Reject $H_0$ |
| | $H_0$: $\delta_1=\delta_2=\ldots=\delta_5=0$ | 5 | 11.07 | 90.32 | Reject $H_0$ | 65.7 | Reject $H_0$ |
| Widow allowance | **Testing the functional form of the production frontier** | | | | | | |
| | $H_0$: The production frontier is Cobb-Douglas form | 28 | 41.34 | 64.24 | Reject $H_0$ | 64.92 | Reject $H_0$ |
| | $H_0$: The trans-log stochastic frontier model exhibits constant returns to scale. | 5 | 11.05 | 29 | Reject $H_0$ | 33.58 | Reject $H_0$ |
| | **Tests of hypotheses on the parameters of the technical inefficiency effect model** | | | | | | |
| | $H_0$: $\gamma=\delta_0=\delta_1=\ldots=\delta_5=0$ | 8 | 15.51 | 15.6 | Reject $H_0$ | 118.6 | Reject $H_0$ |
| | $H_0$: $\gamma=0$** | 3 | 7.81 | 7.9 | Reject $H_0$ | 99.64 | Reject $H_0$ |
| | $H_0$: $\delta_1=\delta_2=\ldots=\delta_5=0$ | 5 | 11.07 | 74.2 | Reject $H_0$ | 65.6 | Reject $H_0$ |
| Disables allowance | **Testing the functional form of the production frontier** | | | | | | |
| | $H_0$: The production frontier is Cobb-Douglas form | 28 | 41.34 | 37.24 | Accept $H_0$ | 10.34 | Accept $H_0$ |
| | $H_0$: The trans-log stochastic frontier model exhibits constant returns to scale. | - | - | - | - | - | - |
| | **Tests of hypotheses on the parameters of the technical inefficiency effect model** | | | | | | |
| | $H_0$: $\gamma=\delta_0=\delta_1=\ldots=\delta_5=0$ | 8 | 15.51 | 24.16 | Reject $H_0$ | 69.7 | Reject $H_0$ |
| | $H_0$: $\gamma=0$** | 3 | 7.81 | -1.56 | Accept $H_0$ | 52.12 | Reject $H_0$ |
| | $H_0$: $\delta_1=\delta_2=\ldots=\delta_5=0$ | 5 | 11.07 | 15.94 | Reject $H_0$ | 67.28 | Reject $H_0$ |
| | | | | | | | |

***λ = -2 [ln {L(H0)} – ln {L(H1)}], **γ = 0 indicates that σu Squared = 0 and δ0 = 0, so df 3.***

**Appendix Table 2: Estimates of the parameters of the Trans-log stochastic model for the outcome variables food expenditure and health care expenditure for *Old Age Allowance and Allowance for the Widowed***

| Variable | Parameter | Old age allowance | | Widow allowance | |
|---|---|---|---|---|---|
| | | Food Expenditure | Health Care Expenditure | Food Expenditure | Health Care Expenditure |
| Intercept | $B_0$ | 4.41*** | 32.786*** | 8.774** | 52.680*** |
| Family Size | $B_1$ | 2.11** | 11.093*** | -1.930 | -17.89*** |
| Education of the household head | $B_2$ | 0.03 | -1.029 | -2.479** | 4.284* |
| Land Size | $B_3$ | -0.14 | 0.648 | -0.186 | 4.669*** |
| SSNP Income | $B_4$ | 0.64** | -2.703*** | -0.640 | -11.80*** |
| Asset Score | $B_5$ | -0.79 | -14.813 | 5.828*** | 6.692* |
| Dependency Ratio | $B_6$ | 1.06** | -0.279 | -0.293 | 3.108** |
| Donation received | $B_7$ | -0.04 | 0.026 | 0.052 | -0.014 |
| Family Size Squared | $B_8$ | 0.20*** | 0.436** | 0.201* | 0.414* |
| Education Squared | $B_9$ | 0.07** | 0.040 | 0.043 | -0.287*** |
| Land Size Squared | $B_{10}$ | 0.01** | 0.018 | 0.017 | 0.068** |
| SSNP Income Squared | $B_{11}$ | 0.01 | 0.007 | 0.097 | 0.755*** |
| Asset Score Squared | $B_{12}$ | 0.20*** | 0.180 | 0.126 | 0.137 |
| Dependency Ratio Squared | $B_{13}$ | 0.01 | -0.028 | -0.009 | -0.060** |
| Donation Squared | $B_{14}$ | 0.01*** | 0.036*** | 0.013*** | 0.025*** |
| Family Size × Education | $B_{12}$ | -0.06 | -0.237 | -0.131 | 0.316*** |
| Family Size × Land Size | $B_{13}$ | -0.01 | -0.023 | -0.032 | 0.065 |
| Family Size × SSNP Income | $B_{14}$ | -0.12 | -1.281*** | 0.344 | 2.313 |
| Family Size × Asset Score | $B_{15}$ | -0.17** | -0.200 | -0.233** | -1.097*** |
| Family Size × Dependency Ratio | $B_{16}$ | -0.11** | 0.006 | -0.044 | -0.044 |
| Family Size × Donation | $B_{17}$ | 0.02** | 0.020 | 0.012 | 0.034 |
| Education × Land Size | $B_{23}$ | 0.00 | -0.021 | 0.004 | -0.012 |
| Education × SSNP Income | $B_{24}$ | -0.01 | 0.145 | 0.269** | -0.551* |
| Education × Asset Score | $B_{25}$ | -0.07* | 0.114 | 0.144** | 0.345 |
| Education × Dependency Ratio | $B_{26}$ | 0.04 | -0.012 | -0.021 | -0.012 |
| Education × Donation | $B_{27}$ | -0.01** | -0.023* | -0.001 | 0.003 |
| Land Size × SSNP Income | $B_{34}$ | -0.01 | -0.075 | 0.004 | -0.580*** |
| Land Size × Asset Score | $B_{35}$ | -0.01 | -0.003 | 0.049* | -0.108* |
| Land Size × Dependency Ratio | $B_{36}$ | 0.05*** | -0.006 | -0.001 | 0.052* |
| Land Size × Donation | $B_{37}$ | 0.00 | -0.002 | 0.003 | 0.030*** |
| SSNP Income × Asset Score | $B_{45}$ | 0.04 | 1.589*** | -0.752*** | -0.691* |
| SSNP Income × Dependency Ratio | $B_{46}$ | -0.13** | 0.012 | 0.031 | -0.316* |
| SSNP Income × Donation | $B_{47}$ | -0.01 | -0.034 | -0.020 | 0.000 |
| Asset Score × Dependency Ratio | $B_{56}$ | -0.02 | 0.154* | 0.055** | -0.077* |
| Asset Score × Donation | $B_{57}$ | 0.01* | 0.027 | 0.006 | -0.097*** |
| Dependency Ratio × Donation | $B_{67}$ | 0.00 | -0.008 | -0.003 | -0.009 |
| **Inefficiency Model:** | | | | | |
| Intercept | $\delta_0$ | -26.39*** | -13.361*** | -12.376* | -116.99** |
| Female Headed | $\delta_1$ | 2.92*** | -10.648*** | 1.796** | 0.762 |
| Income Status | $\delta_2$ | -1.29*** | 7.259*** | 1.096* | 6.747*** |
| Poverty Score | $\delta_3$ | -0.01 | -0.604*** | -0.004 | -0.043 |
| Food Security | $\delta_4$ | 0.92** | -13.946*** | -1.509 | 2.750*** |
| Working Status | $\delta_5$ | 1.03*** | 3.027*** | 2.827 | 10.895*** |
| **Variance parameters** | $\sigma^2$ | 9.31*** | 106.959** | 1.581* | 147.755** |
| | $\gamma$ | 0.99*** | 0.997*** | 0.937*** | 0.999*** |
| **Log-likelihood value** | | -336.72 | -1090.75 | -152.30 | -552.40 |
| **** and ** and * indicate significance at $p < 0.01$ and $p < 0.05$ and $p < 0.10$ respectively.* | | | | | |

**Appendix Table 3: Estimates of the parameters of the Cobb-Douglas production frontier model for the outcome variable food expenditure and health care expenditure for *Allowance for the Disables***

| Variable | Parameter | Food Expenditure | | Health Care Expenditure | |
|---|---|---|---|---|---|
| | | Coefficient | Standard Error | Coefficient | Standard Error |
| Intercept | $B_0$ | 10.448*** | 0.967 | 4.316*** | 1.240 |
| Family Size | $B_1$ | 0.814*** | 0.094 | 0.544*** | 0.228 |
| Education | $B_2$ | -0.007 | 0.050 | 0.141 | 0.120 |
| Land Size | $B_3$ | -0.055** | 0.025 | -0.003 | 0.063 |
| SSNP Income | $B_4$ | -0.095 | 0.112 | 0.485*** | 0.148 |
| Asset Score | $B_5$ | 0.184** | 0.072 | 0.169 | 0.198 |
| Dependency Ratio | $B_6$ | -0.001 | 0.018 | -0.008 | 0.043 |
| Donation received | $B_7$ | 0.006 | 0.007 | 0.034*** | 0.015 |
| **Inefficiency Model:** | | | | | |
| Intercept | $\delta_0$ | 0.391 | 1.222 | -2.587*** | 1.067 |
| Female headship | $\delta_1$ | 0.614* | 0.422 | 11.271*** | 4.027 |
| Income regularity status | $\delta_2$ | -1.413** | 0.621 | -10.22*** | 4.282 |
| Poverty Score | $\delta_3$ | -0.072*** | 0.029 | -0.946*** | 0.369 |
| Food security status | $\delta_4$ | 1.425* | 0.934 | -15.22*** | 6.013 |
| Currently working status | $\delta_5$ | 0.154 | 0.243 | 20.358*** | 7.972 |
| **Variance parameters** | $\sigma^2$ | 0.623*** | 0.187 | 96.035*** | 35.042 |
| | $\gamma$ | 0.819*** | 0.062 | 0.998*** | 0.001 |
| **Log-likelihood value** | | -90.98 | | -318.62 | |

**** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level*