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Analysis of Price Efficiency of Smallholder Farmers in Maize Production in Gudeya Bila District, Oromia National Regional State, Ethiopia: Stochastic, Dual Cost approach

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Abstract
Even if Ethiopia had adopted different strategy and policies the productivity of agricultural production is not as meet the demand of the peoples. The aim of this study was to analyze productivity and price efficiency of smallholder farmers in maize production in the study area. To meet the stated objectives primary data were collected using structured questionnaires from 154 randomly selected sample households during the 2017/18 production year. Copdoglous production function was applied to analysis productivity where as dual cost is used to estimate price efficiency. Tobit model was used to identify factors affecting price efficiency level. Price efficiency were 70.06%. Thus the results reveal exists considerable levels of price inefficiencies in maize production in study area. The Tobit model results revealed that livestock holding and participation in off/non-farm activities had positive effect and distance of maize plot from home were found to had negative effect on price efficiency The result indicated that there exists a room to increase the price efficiency of maize producers in the study area. For realizing significant price efficiency gains policies and strategies of the government should be directed towards increasing farmer's livestock holding and promoting off/non-farm activities.
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1. INTRODUCTION

Agricultural sector in Ethiopia it remains rain-fed and majority of smallholder farming engaging on less than a hectare of land (1). More recently the second Growth and Transformation Plan (GTP –II) also made agricultural growth as its core growth program at the national level and to maintain it as a source of economic growth. Besides this fact, agriculture remains the main economic growth and development option in Ethiopia which is estimated to increase at annual average growth rate of 8% during GTP II period (NPC, 2015).Despite such strategies and policies, the sector is characterized by its low productivity, which is attributed to limited access to agricultural inputs such as fertilizer and improved seeds ,inefficiency resource use , limited access to finance, agricultural markets and poor land management [3 , 1).

Maize is important for poor households as they mix maize flour with teff to make the national staple injera, and the cost of maize is half that of wheat and teff[4].In Ethiopia, maize grows under a wide range of environmental conditions between 500 to 2400 meters above sea level. Maize is cultivated in different parts of Ethiopia, mainly Oromia, Amhara, Southern Nations and Nationalities Peoples and Tigray regions and it is the first most important cereal crop in East Wollega Zone [5]. Maize is produced by 5.36 million smallholders in Oromia region and occupies 1.14 million hectare of land with an output and productivity of 43.62 million quintal and 38.26 quintal/hectare respectively [6].maize yield levels in Ethiopia are still very low caused by institutional, social and economic factor, risk issue and suboptimal crop management [7]. In addition, maize yields are inevitably affected by weather condition, limited input, limited a favorable policy, quality of seed varieties and limited techniques of production [6].Although, the analysis of technical efficiency of maize farming is important, there was limited empirical research done so far particularly on the estimation price efficiencies. Therefore, this study intended to fill this information and knowledge gaps in Gudeya Bila district where such type of work has not been conducted for efficiency of maize production.

1.4. Objectives of the Study

1.4.1. General objectives

The general objective of the study was to analyze price and cost efficiency of smallholder farmers in maize production in Gudeya Bila district of East Wollega Zone.

1.4.2. Specific objective

The specific objectives of the study were the following:
1. To measure the levels of price efficiency of smallholder maize producers in the study area.
2. To identify the factors that affect price efficiency of smallholder maize producers in the study area.

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3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

This study was carried out in Gudeya Bila district, which is one of the 17 districts located in the East Wollega zone of Oromia National Regional State in the Western part of Ethiopia. It encompasses agro-ecologies of highland, mid-altitude and lowland with proportion of 17.6% and 55.8%and 26.6%, respectively. The district is bordered by Jima Ganeti and BakoTibe districts in east, Guto Gida and SibuSire districts in west, Abe Dongoro district in north and Gobbuu Sayyoo district in south. It is located at 104 from the zonal capital and 274km from Addis Ababa, capital of Ethiopia to west. It lies between 37^0 01' 28"N latitude and 9^0 17'23" S longitudes. Altitude ranges between 500 to 3500 meters above sea level [8].According to[9] population projection, the district has a total estimated population of 71629 of whom 49.2% are men and 50.8% are women; and 86.85% of its population is rural dwellers.

3.2. Sampling Techniques and Sample Size Determination

Two stages random sampling technique was used to select sample household for this study. In first stage out of 13 kebeles exist in the district three kebeles namely Darbas, Tibe, and Haro Gudisa were randomly selected. In second stage 154 samples household were selected by simple random sampling by lottery method from three kebeles household taking into account probability proportional to the size of maize producers in each sample kebeles. Accordingly, 154 households were selected for survey from 8765 households.

3.3. Type, Sources and Methods of Data Collection

This research is basically relied on quantitative and qualitative types of data collected from both primary and secondary sources. To address the stated objectives of the study, primary data was collected from 154 households with information collected at household level using structured questionnaire and also focus group discussions obtained from maize dominant farmers.

3.4. Methods of Data Analysis

In this study, both descriptive and econometric models were used to analysis the data collected from sample farm households.

In econometric estimation method Stochastic frontier approach was employed to estimate level price efficiency and Tobit model was used to identify factors that affect the price efficiency level of the maize farmers using Stata13 software. The detailed econometric models specifications for analysis of efficiency level and its determinant discussed below.

3.4.1. Dual cost approach of Efficiency measurement

[11] Suggests that the dual cost frontier of the Cobb Douglas production functional form in equation defined as which is used to estimate price efficiency

$$Ci = C(Wi, Yi^*, \alpha) \quad (1)$$

Where i refers to the ith sample household; Ci is the minimum cost of production; Wi denotes input prices; Y^* refers to farm output which is adjusted for noise V_i and $\alpha's$ are parameters to be estimated.

3.4.2. Determinants of price efficiency

After estimating the level of price efficiency from stochastic frontier model they was regressed using a two limit Tobit model on farm specific explanatory variables that affect in efficiency level. Following [12] Tobit regression is specified as:

$$y_i^* = \delta_0 + \delta_m Z_{im} + \mu \quad (2)$$

Where $y_i{}^* -$ latent variable representing the price efficiency scores of i^{th} farm

$m-$ the number of factors affecting efficiency, $\delta -$ a vector of parameter to be estimated , $Z_{im} -$represents farm specific factors affecting efficiency of i^{th} farm, $\mu -$ error term that is independently and normally distributed with zero mean and variance δ^2 Denoting y_i as observed variables,

$$y_i = \begin{cases} 1 & if\, y_i^* \geq 1 \\ y_i^* & if\, 0 < y_i^* < 1 \\ 0 & if\, y_i^* \leq 0 \end{cases} \quad (3)$$

Following [13] the likelihood function of this model is given by:

$$L(\beta,\sigma / y_i L_{1j}, L_{2j}) = \prod_{y_j = l_{1j}} \varphi\left(\frac{L_{1j} - \beta' X_j}{\sigma}\right) \quad (4)$$

Where L_{1j} = 0(lower limit) and L_{2j}=1(upper limit) are

$$\prod_{y_j = y_j^*} \frac{1}{\sigma} \phi\left(\frac{y_j - \beta' X_j}{\sigma}\right) \prod_{y_j = l_{2j}} 1 - \varphi\left(\frac{L_{2j} - \beta' X_j}{\sigma}\right)$$

normal and standard density functions.

In a two-limit Tobit model, each marginal effect includes both the influence of explanatory variables on the probability of the dependent variable to fall in the uncensored part of the distribution and on the expected value of the dependent variable conditional on it being larger than the lower bound. Thus, the total marginal effect takes into account that a change in explanatory variable will have a simultaneous effect on the probability of being efficient and value of efficiency scores in maize production.

McDonald and Moffitt (1980) proposed useful decomposition techniques of total marginal effects. Based on the likelihood function of the model stated in equation (4), the total marginal effect divided into the three marginal effects as follows:

1. The unconditional expected value of the dependent variable:

$$\frac{\partial E(y)}{\partial x_j} = [\varphi(Z_u) - \varphi(Z_L)] \frac{\partial E(y^{|*})}{\partial x_j} + \frac{\partial [\varphi(Z_U) - \varphi(Z_L)]}{\partial x_j} + \frac{\partial (1 - \varphi(Z_U))}{\partial x_j} \quad (5)$$

2. The expected value of the dependent variable conditional upon being between the limits:

$$\frac{\partial E(y^*)}{\partial x_j} = \beta_k \left[1 + \frac{\{Z_L \varphi(Z_L) - Z_U \varphi(Z_U)\}}{\{\varphi(Z_U) - \varphi(Z_L)\}}\right] - \left[\frac{\{\phi(Z_L) - \phi(Z_U)\}^2}{\{\varphi(Z_U) - \varphi(Z_L)\}^2}\right] \quad (6)$$

3. The probability of being between the limits:

$$\frac{\partial [\varphi(Z_U) - \varphi(Z_L)]}{\partial x_j} = \frac{\beta_m}{\sigma} . [\phi(Z_L) - \phi((Z_U)] \quad (7)$$

Where φ (.) = the cumulative normal distribution, ϕ(.) = the normal density function,

$Z_1 = -\beta' X / \sigma$ and $Z_U = (1 - \beta X) / \sigma$ are standardized variables that came from the likelihood function given the limits of y^*, and σ = standard deviation of the model.

4. RESULTS AND DISCUSSION

Major crops production and their area coverage

Crop production is major activities in the study area. The major crops grown in the areas include maize, teff, niger seed, sorghum, wheat, and barley. On average, sampled households allocated 0.80 hectare of cultivated land for maize production. Next to maize teff and niger seed were crops that took the lion's share of the farmer`s total cultivated land covering 0.34 and 0.18 ha of land, respectively. The sample households also allocated 0.06 of the total cultivated land for wheat. Moreover, sorghum and barley were crops that took certain share of households total cultivated land covering, 0.03 and 0.02 ha, respectively. Table 1 also demonstrates the average production of major crops in quintals. Sampled farmers on average got 23.05 quintals of maize, which were 75.39% of the total major crop production. The total average production of teff and wheat was 2.68, 2.14 quintals, which was 8.75%, 7% of the total major crop production. Sampled households on average also got 1.61, 0.68 and 0.38 quintals of sorghum, Niger seed and barley which was tooks some share of 5.27%, 2.25% and 1.27% respectively.

Table 1.Average crops production of various crop output by sample households

		Area(ha)		Production(Qt)	
Crop type	No. farmer	Mean	percent	Mean	percent
Maize	154	0.80	54.95	23.05	75.39
Teff	104	0.34	23.66	2.68	8.79
Niger seed	64	0.18	12.52	0.68	2.25
Wheat	34	0.06	4.45	2.14	7.00
Sorghum	29	0.03	2.54	1.61	5.27
Barley	12	0.02	1.41	0.38	1.27

Source: Own survey (2018)

Econometric Model Outputs

Price efficiency score

Table 2.Summary statistics of efficiency score of sample households

Variables	Observation	Mean	Std.devation	Min	max
PE	154	0.7006	0.1297	0.2855	0.9462

Source: Own computation (2018)

The mean price efficiency of farmers in the study area was 70.06% and ranges from 28.53% to 94.62% indicating that on average, maize producer households can save 29.94% of their current cost of inputs if resources are efficiently utilized. This shows that there is enormous opportunity to increase the efficiency of maize producing households by reallocation of resources in cost minimizing way. The most price inefficient farmer would have an efficiency gain of 69.82% derived from $(1 - 0.2855 \ / \ 0.9462\ ) * 100$ to attain the level of the most price efficient household. The mean levels of price efficiencies are comparable with the results from other similar studies in Ethiopia. For example Sisay *et al.* (2015) obtained price efficiency of 57.1% in south-western Ethiopia

4.2.4. Distribution price efficiency scores

The distribution of price efficiency revealed that, 44.2% of the sampled maize producers were in the range of between 70%-79.99%. Households in this group can save at least 20% of their current cost of inputs by behaving in a cost minimizing way. Followed by 18.2% range from 60%-69.99%.Only 1.3% of the total sample households had an price effeciency score that ranged between 90% and 100%. This shows that almost maize producing households (98.7%) can at least save 10% of their current input cost by reallocation of resources in cost minimizing way.

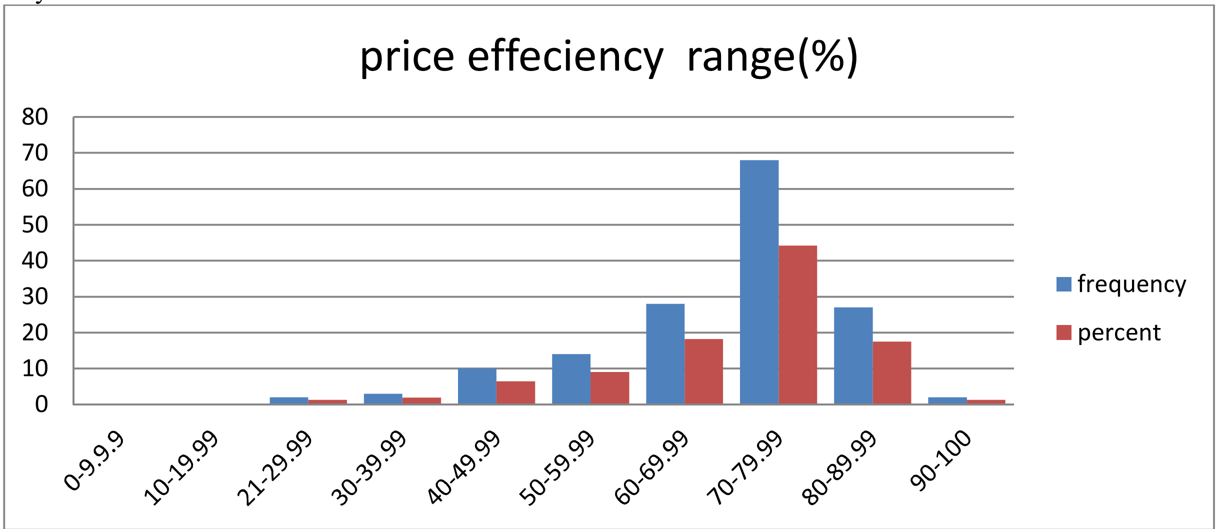

Figure 1.Distribution of price efficiency scores (%)

Source: Own computation (2018)

4.2.5. Determinants of price efficiency in maize production

After measuring levels of farmer efficiency in maize production price efficiency estimates derived from the model were regressed on demographic, socioeconomic, institutional factor and farm characteristics variables that affect efficiency of farm households using two limits Tobit regression model (Table 3)

Table 3.Tobit model estimates for determinant of efficiency

	Price efficiency	
Variables	Coefficient	Std.Err
Constant	0.70755***	0.06397
AGEHHD	-0.00119	0.00114
SEX	-0.00227	0.02524
EDUC	-0.00452	0.00321
FMSIZE	0.00594	0.00792
FRMSIZE	-0.0047	0.01258
LIVSTK	0.00596*	0.00313
FERTY	0.03369	0.02059
DISPLOT	-0.00207**	0.00096
DISMRKT	0.00522	0.00560
EXTEN	-0.00105	0.00108
CREDIT	-0.0003	0.02121
OFF/NFRM	0.03816*	0.02165
Loglikehood	100.61	

Note: *, **and *** significant at 10%, 5% and 1% level of significance, respectively
Source: Own computation (2018)

Table 4.The marginal effects of change in explanatory variables

	Price efficiency		
Variables	$\frac{\partial E(y)}{\partial X_j}$	$\frac{\partial E(y^*)}{\partial X_j}$	$\frac{\partial(\phi(Z_U - Z_L)}{\partial X_j}$
LIVSTK	0.00582	0.00526	0.00258
DISPLOT	-0.00202	-0.00182	-0.00089
OFF/NFRM	0.03728	0.03368	0.01634

Note: Those computed marginal effects are $\frac{\partial E(y)}{\partial X_j}$ (total change), $\frac{\partial E(y^*)}{\partial X_j}$ (Expected change) and $\frac{\partial(\phi(Z_U - Z_L)}{\partial X_j}$ (Change in probability) for their respective significant coefficient of determinant are discussed in this study.

Livestock holding: The coefficient for livestock holding (TLU) was positive and had a significant influence on price efficiency at 10% level. The result reveal that having largest number of livestock holding helps to shifts cash constraint, provide manure and to satisfy all needs of farmers in the study area. Each unit increase in the value of TLU would increase the probability of a farmer being efficient price by 0.26% and the expected value of price efficiency by about 0.53% with an overall increase in the probability and the level of efficiencies by 0.58%. This finding was consistent with the result obtained by (Getachew, 2017).

Distance of maize plot from home: The coefficient distance of maize plot from farm household is negative and significant at 5% levels of significance on price efficiency. This relation may be because those farms plot far away from household residence will receive less management and the frequency of visits may reduce. Unit change distance of plot from home would decrease the probability of a farmer being efficient in price allocation by 0.09 and the expected value of price efficiency decrease by 0.18% with an overall decrease in the probability and the level of efficiencies by 0.2 %. This is in line with (kinde, 2005).

Participation in off/non-farm activities: In this study the coefficient of participation in off/non-farm activity was positive sign and statistically significant 10% level of significance effect with price efficiency as expected. The reason is the income obtained from such activities could be used for the purchase of agricultural inputs and supplement financing of household expenditures which they cannot provide from the farm income hence increases their efficiency. Moreover, a change in the dummy variable representing the participation in off/non-farm activities by the household ordered from 0 to 1 would increase the probability of the farmers efficient in price allocation by 1.63 and change the expected value of price efficiency by 3.37 with an overall increase in the probability and the level of price efficiencies by 3.73%. This result is in line with the findings of (Gizachew, 2018).

5. SUMMARY AND RECOMMENDATIONS

5.1. Summary

Despite Ethiopian government followed different strategies and policies, agricultural the sector is characterized by its low productivity Thus this study was conducted to analyze price efficiencies and identifies factors that affect efficiency of smallholder maize producers in Gudeya Bila district, Oromia National Regional State, Ethiopia.

In this study, two stage random sampling procedure was used to select sample of 154 maize producer households for survey that represent total population. Both primary and secondary data were used. Primary data source were collected using structured questionnaire and focus group discussion. To support the primary data, secondary data from different sources were collected. Data analysis was carried out using descriptive statistics and econometric models. Dual cost frontier model was used to price efficiency.

Dual cost function indicates that the average price efficiency value of the sample households was 70.06%. price efficiency was affected by livestock holding, participation in off/non-farm activities positively and significantly and negatively affected by distance of maize plot from home as expected. These factors have important policy implications in that to mitigate the existing level of inefficiency of households in the maize production and development programs should act upon these variables.

5.2. Recommendations

Given the importance of maize and the observed considerable room to improve the level of price efficiency of maize producers the following recommendations are drawn:

The result of the analysis showed that maize producers in the study area are not operating at full price efficiencies levels. Therefore intervention aiming to improve price efficiency of farmers in the study area has to give due attention for resource allocation. The study results also revealed that there is a considerable variability in price efficiencies score of sample household in the production of maize in the study area. Therefore less price efficient farmers increase their efficiency level by adopting the practices of relatively efficient farmers in the area.

Given the mixed farming system in the study area, farmers with more number of livestock were relatively better in the price efficiency. Hence, there is a need to design appropriate policy and strategies for improving livestock production systems by solving the shortage of feed and health services which in turn will enhance the efficiency. As information obtained from FGD mixing of urea with straw started recently in the study area as additional source of feed to increase productivity of livestock so it should be encouraged and supported by livestock office that in turn increases efficiency of farmers.

The study offers significantly and positive relationship between participation in off/non-farm activities and price efficiencies. This indicates that, rural development strategies should not only emphasize on increasing agricultural production but simultaneous attention should be given to promote off/non-farm activities and work diversification in the rural areas regarding to off/non-farm activities. There is also need for the government organizations to train farmers on off/non-farm entrepreneurship, so that they can earn profits from off/non-farm income generating activities through which they will acquire the needed farming capital thus helps to increase efficiency in maize production.

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