GPJ

Volume 3   August 2009

Editorial   4

Articles

DETERMINANTS OF TECHNICAL EFFICIENCY OF WOMEN ENTREPRENEURS
IN THE FOOD PROCESSING ENTERPRISES IN CAPE COAST*

by

Vijay Bhasin [1]

ABSTRACT

The study looks at the determinants of technical efficiency of women food processors in Cape Coast, Ghana. The study estimates the Cobb-Douglas frontier production function for the women food processors. Electricity, water, equipment and man-hours worked are found to be the significant determinants of value of output. The elasticity of labour with respect to output is noticed to be the highest. The distribution of technical efficiency shows that there is ample scope for the improvement of technical efficiency of women food processors. The significant determinants of technical efficiency of women food processors are found to be the level of education, number of children, access to credit, and adoption of new and efficient technologies at work place. The Government of Ghana should design policies to concentrate on these significant determinants of technical efficiency to alleviate poverty of women food processors in Cape Coast.

Keywords: entrepreneurship, food processing, frontier production function, small and medium enterprises, technical efficiency, technology at work place, women advancement.

[1] Department of Economics, University of Cape Coast, Cape Coast, Ghana. The email address of Dr. Bhasin is as follows:
vbhasin96@yahoo.com

1. INTRODUCTION

Although women form a significant percentage of the human population, they earn only 10% of the world's income, and own less than 10% of the world's property (UNIFEM, 1997). Women, partners of men in the administration of resources, are undeniable colleagues in the production of goods and services. The formal sector employs a small percentage of workers but controls a disproportionate amount of resources. The informal sector, although with minimal resources, provides employment for a large percentage of people. In the informal sector, women appear to be more than men. They are in activities generally reserved for women. These are petty trading of diverse articles (clothes, shoes, cosmetics, jewellery and others), sale of foodstuffs, catering, tailoring and other types of services (hairdressing, massage, cosmetic services, food processing, etc.). In all countries, women as a group are disadvantaged as compared to men as a group (UNDP, 1997). Women have limited access to essential resources such as education, land, technology and credit. Moreover, they are at a disadvantaged position as far as the formal sector employment is concerned. In such a case, the informal sector is the only sector that can provide employment for the disadvantaged group.

Empirical literature on the importance of technology to women's ventures has often considered technology and rural women rather than urban women especially in agricultural production and processing (Boserup, 1970; Whitehead, 1981, 1985; Adekanye, 1985; Stamp, 1989). This is not strange given that African women are primarily food producers and processors, and rural dwellers. However, as more women move to urban areas and obtain some education, new economic opportunities are opened for them, usually in the informal sector. Women in Ghana generally have less access to formal education, credit and technology, and therefore have low participation in the formal sector. Many women take up self-employment after fulfilling apprenticeship requirements in the micro enterprises, which fall in the informal sector. These include technology-related occupations such as hairdressing, dressmaking, food processing, and tie and dye.

Studies on technology and urban women have tended to focus their attention on the labour force participation (Joll *et al.*, 1983; Trager, 1987; Okine, 1989; Psacharopolous et al., 1989; Gazier, 1992; ILO, 1994; Lachaud, 1996), with the exception of Soetan (1996); while ignoring the relationship between the adoption of new technologies at work-places and technical efficiency of women

food processors. Technical efficiency is measured as the ratio of the actual and potential output. The adoption of new technologies at the work-place is defined as the use of new and efficient milling machines (capital embodied technological change). Since the adoption of new and efficient milling machines increase both the actual and potential output, it will impact the technical efficiency positively.

It has been noticed in the literature that discriminatory treatment based on gender is bad for efficiency and growth (Elson and Evers, 1997). For example, studies from agriculture in Africa indicate that if women and men shared the same educational levels and access to modern inputs (improved seeds, fertilisers, extension services, etc.), yields could increase as much as 22% for food crop farmers, and that giving women primary schooling alone would raise yields by 24% for maize farmers (World Bank, 1995). A study from Tanzania shows that reducing time constraints in a community for small holder coffee and banana growers could increase household cash incomes by 10%, labour productivity by 15%, and capital productivity by 44% (Elson and Evers, 1997).

In the market sector of the economy, discrimination based on gender is often hidden and sometimes difficult to reveal (Elson and Evers, 1997). Discriminatory access to productive assets (land, modern inputs, capital, etc.) has also been shown to have a negative impact on economic efficiency and growth. For example, discrimination on the labour market means that wages paid to women underestimate women's productivity, and thus underestimates the returns to women and society. Moreover, discrimination in the credit market means that women are either denied credit or that the rates of interest charged from women overestimate the risks of lending to women and underestimate the returns to women and society. Clearly, all such distortions reduce the overall efficiency of the economy. Efficiency also depends on the health status of women. Haddad and Kennedy (1992) have noted that there are strong efficiency reasons why policy makers should improve women's nutrition. According to Fogel (1994), there exists causal relationship between health and productivity and efficiency of women in low-income countries. In addition, the importance of different forms of human capital to the enhancement of productivity and efficiency of workers has been emphasised by Bouis (1990), Berham (1996) and Schultz (1997).

The incomes of women food processors could be increased by increasing the factors' productivity or their technical efficiency. It is very difficult to increase the productivity of different factors of production under uncertain economic

environment. Thus, the only option left is to increase the incomes of women food processors by increasing their technical efficiency. The challenge to policy makers is to know whether technical efficiency of women entrepreneurs (food processors) can be increased through the adoption of new and efficient technologies their at work place or some other factors so that the economic status of women can be improved. This could only be done when the policy makers know which ones of the following are the significant factors that influence their technical efficiency.

It is argued that technical efficiency is determined by individual characteristics of women entrepreneurs. Factors influencing such characteristics may be divided into two groups - human capital variables that dominate the decision-making process of women entrepreneurs, and institutional variables that could influence women entrepreneurs' capacity to apply their decisions at the enterprise level without any constraints. The human capital variables are: age of operator, level of education, business experience, leisure time, number of children and health status; and institutional variables are access to credit and adoption of new and efficient technologies at work place. Age of operator and number of children are expected to be negatively influencing technical efficiency through actual output. On the other hand, business experience, leisure time, health status, and access to credit are expected to be positively influencing technical efficiency through actual output; whereas level of education and adoption of new and efficient technologies at work place are expected to be positively influencing technical efficiency through actual output as well as potential output.

The study concentrates on Cape Coast which is the capital of the Central Region of Ghana. According to Ghana Statistical Service (2007), Central Region was the fourth poorest region in Ghana in 1998/99 and its position changed to seventh poorest region in Ghana in 2005/06. According to Ghana Statistical Service (2005), women outnumber men in the total population, with a composition of 50.5 and 49.5 per cent, respectively. Women also outnumber men in the urban areas, while in the rural areas; their proportions are about the same. Moreover, in the urban areas, women outnumber men in the private informal sector in trading and other services. Since the incidence of poverty in the Central Region is higher than some of the other regions and more women are engaged in the private informal sector of urban areas, the present study concentrates on the alleviation of poverty of women food processors in Cape Coast by identifying the significant determinants to raise their technical

efficiency and income. The study was confined to Cape Coast only because of time and financial constraints.

The objectives of the study are to:

1. Estimate the appropriate form of production function for the women food processors in Cape Coast.
2. Estimate the technical efficiency of women food processors in Cape Coast.
3. Identify the significant determinants of technical efficiency of women food processors in Cape Coast and suggest policy recommendations.

The study shows that the Cobb-Douglas frontier production function is the most appropriate production function for the women food processors. The distribution of technical efficiency shows that there is ample scope for the improvement of technical efficiency of women food processors because only 5% of women food processors have their technical efficiency which is above 91%. The significant determinants of technical efficiency of women food processors are level of education, number of children, access to credit, and adoption of new and efficient technologies at work place. The paper is organised in six sections. Section One presents Introduction. Section Two reviews both the theoretical and empirical literature. The theoretical model is presented in Section Three. Methodology is explained in Section Four. Section Five presents the Analysis of Findings. The conclusions and policy recommendations follow.

2. LITERATURE REVIEW

The theoretical literature on technical and allocative efficiency emphasises two broad approaches to the estimation of stochastic production frontier and stochastic cost frontier and these are: (a) The non-parametric programming approach and (b) The statistical approach. The estimation of stochastic production frontier provides estimates for the technical efficiency and the estimation of stochastic cost frontier provides estimates for the allocative efficiency. Technical efficiency reflects the ability of a firm to obtain maximal output for a given set of inputs. Allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. In the case of a stochastic production frontier, the value of technical efficiency lies between zero and one, while the value of allocative efficiency lies between one

and infinity in the stochastic cost function case. If the firm operates below the stochastic production frontier then it is considered as technically inefficient (the value of technical efficiency is less than one). On the other hand, if the firm operates above the stochastic cost frontier then it is considered as allocatively inefficient (the value of allocative efficiency is more than one).

The non-parametric programming approach requires one to construct a free disposal convex hull in the input-output space from a given sample of observations of inputs and outputs. This approach can be used where a firm produces multiple outputs. In this approach, estimates can be obtained for technical, allocative and scale efficiencies (Farrell, 1957; Afriat 1972; Hanoch and Rothchild, 1972; Diewert and Parkan, 1983; Varian, 1985; Charnes *et al*., 1994). A major criticism of this approach is that the convex hull, representing the maximum possible output, is derived using only marginal data and not utilising all the observations in the sample. Thus the production efficiency measures are susceptible to outliers and measurement errors (Forsund *et al*., l980). Secondly, the method has very demanding data needs. Finally, this being a non-parametric approach, no statistical inferences from the estimates can be derived.

The statistical approach can be sub-divided into the neutral-shift frontiers and the non-neutral shift frontiers. The former approach provides estimates for the technical and allocative efficiencies by specifying composed error formulations to the conventional production and cost functions (Aigner *et al.,* 1977; Meeusen and van den Broeck, 1977, Schmidt and Lovell 1979; Jondrow *et al*., 1982; Lee, 1983; Huang, 1984; Schmidt and Sickles, 1984; Schmidt, 1986; Waldman, 1984; Greene, 1988; Bauer, 1990; Cornwell *et al*. , 1990; Kumbhakar, 1990; Fried *et al*. , 1993; Coelli, 1995; Battese and Coelli, 1995). The latter approach uses a varying coefficients production function formulation (Kalirajan and Obwona, 1994; Obwona, 1995). A major criticism of the statistical approach is that it cannot provide estimates for the technical and allocative efficiencies for those firms that produce multiple outputs.

The empirical literature on the measurement of technical and allocative efficiency in the agricultural, manufacturing and services' sectors of sub-Saharan African countries is very limited. Croppenstedt and Demeke (1997) have estimated the technical efficiency of private farmers engaged in the cereal crop production in Ethiopia and observed that education is weakly correlated with farm efficiency. Admassie and Asfaw (1997) have estimated the technical

and allocative efficiency of farmers in Ethiopia and observed that educated farmers are relatively and absolutely more efficient than those without education, and the mean profit efficiency of farmers is 54 percent. Croppenstedt and Muller (1998) have noted that the average farm specific efficiency of farmers in Ethiopia ranges from 51 to 76 percent depending on the assumed distributional form of the one-sided error.

Njikam (1998) has examined the impact of trade liberalisation on the technical efficiency of electrical industry of Cameroon and found a positive effect of trade policy liberalisation on this technical efficiency. Weir (1999) has observed that the farm-level efficiency in Ethiopia is approximately 55 percent and increased schooling reduces inefficiency of farmers. It has been established by Ajibefun and Daramola (1999) for the Block Making, Metal Fabricating and Sawmill industries of Nigeria that the age of operator, level of education and the level of investment are the most significant determinants of both technical and allocative efficiency. In another study Obwona (2000) has shown for the tobacco growers of Uganda that the most significant determinants of technical efficiency are the family size, level of education, health status, hired workforce, credit accessibility, and fragmentation of land and extension services. Weir and Knight (2000) have observed for farmers in Ethiopia that a one year increase in average schooling attained in the household reduces measured farm inefficiency in the production of cereal crops by 2.1 percentage points. Thus, if educational attainment is raised from zero to four years of primary schooling on average in the household, mean efficiency could increase by 15 percent.

Njikam (2000) has estimated pre and post trade reform stochastic frontier production functions for seven Cameroonian industrial sub-sectors, namely, food, beverage & tobacco, textile & leather, wood & furniture, paper & printing, chemical and rubber, and observed that the mean technical efficiency of the manufacturing sector in the pre-trade reform period was 83.78 and the mean technical efficiency in the post-trade reform was 81.87. The firm-specific technical efficiencies in the post-trade reform period are significantly higher than those of the pre-trade reform period. Bhasin and Akpalu (2001) have shown that the significant determinants of technical efficiency of women entrepreneurs of Cape Coast, Ghana, engaged in hairdressing are age of operator, business experience, credit and contact with the lender. In dressmaking, the significant determinants of technical efficiency of women entrepreneurs are age of operator, level of education and credit. However, the significant determinants of technical

efficiency of male wood processors are age of operator, business experience, training programmes, credit and contact with the lender.

Bhasin (2002) has shown that the significant determinants of technical efficiency of onion growers in the Upper East Region of Ghana are farm experience, distance of the farm from the house of the farmer and extension services. The significant determinants of technical efficiency of pepper growers are age of the farmer, distance of the farm from the market, and extension services. On the other hand, the significant determinants of technical efficiency of tomato growers are age of the farmer, level of education, distance of the farm from the house of the farmer, and soil fertility management practices. It seems that no work has been done so far in Ghana on the determinants of technical efficiency of women food processors. It is important to look at the determinants of technical efficiency of women food processors in Ghana, particularly Cape Coast because of the poverty status of the Central Region and the role women play in the private informal sector of urban areas.

3. THEORETICAL MODEL

In this study, we use the stochastic frontier, also called "Composed error" model of Aigner *et al*. (1977) and Meeusen and van den Broeck (1977). Consider a firm using k inputs (x_1, x_2 ...,x_k) to produce a single output Y. Efficient transformation of inputs into output is characterised by the production function, which shows the maximum output obtainable from various input vectors. Technical efficiency is defined as the ratio of the actual output and potential output. Moreover, the concept of technical efficiency refers to the management of resources in an efficient manner. The estimates for the technical efficiency can be obtained by using the stochastic frontier production function that is defined as shown in Equation .:

$$Y_i = x_i \beta + (V_i - U_i) , \; i = 1, 2, ...N \qquad \text{Equation 1}$$

where Y_i is the production (or the logarithm of the production) of the ith firm;
$\quad$ x_i is a k X 1 vector of input quantities of the ith firm;
$\quad$ β is a vector of unknown parameters;
$\quad$ V_i are random variables; and
$\quad$ U_i are non-negative random variables, which are assumed to account for technical inefficiency.

The random errors, V_i, are assumed to be independently and identically distributed as N $(0, \sigma_V^2)$ independent of U_i's. The U's are also assumed to be independently and identically distributed as, for example, exponential (Meeusen and van den Broeck, 1977) and half normal (Aigner et. al., 1977). In the present study, we assume that U's follow half normal distribution and use mixed chi-square distribution (Likelihood Ratio Test) to test for the one-sided error. Technical efficiency (TE) of an individual firm in the context of the stochastic frontier production function (1) is defined as in Equation 2

$$TE_i = E(Y_i \,*/\, U_i, x_i) / E(Y_i \,*/\, U_i = 0, x_i) \qquad \text{Equation 2}$$

where $Y_i *$ is the production of the ith firm, which will be equal to Y_i when the dependent variable is in original units and will be equal to $\exp(Y_i)$ when the dependent variable is in logs. If we decide to use the log version of equation (1) then the technical efficiency is defined as $\exp(-U_i)$. On the other hand, if we decide to use the non-log version of equation (1) then the technical efficiency is defined as $(x_i \beta - U_i)/ (x_i \beta)$. The value of technical efficiency will lie between zero and one. The most efficient firm gets a score of one while the less efficient ones have scores ranging between zero and one. If you look at the form of production function that appears in equation (1), we can say that technical efficiency does not appear as an input in the total production function. This may be because the technical efficiency refers to the management of resources, and it is difficult to measure the degree of management and that is why it cannot appear as an input in the production function.

The maximum likelihood estimates for the parameters of the stochastic frontier production function and the predicted technical efficiency are obtained by using the computer programme, FRONTIER 4.1 (Coelli, 1994), in which the variance parameters are expressed in terms of shown in Equation 3

$$\sigma^2 = (\sigma_U^2 + \sigma_V^2), \text{ and}$$
$$\gamma = \sigma_U^2/(\sigma_U^2 + \sigma_V^2). \qquad \text{Equation 3}$$

The term γ represents the ratio of the variance of inefficiency's error term to the total variance of the two error terms defined above. The value of γ can range between 0 and 1. The significance of the γ parameter can be used to test whether the stochastic frontier production function is preferred to the average production

function. If the null hypothesis, that γ equals zero, is accepted, this would indicate that σ_U^2 is zero and hence that the U_i term should be removed from the model, leaving a specification with parameters that can be consistently estimated using ordinary least squares.

The technical efficiency model is estimated by regressing the predicted technical efficiency on a vector of human capital variables (age of operator, level of education, business experience, leisure time, number of children and health status), and institutional variables (access to credit and adoption of new and efficient technologies at work place). Whether these variables are important for the technical efficiency of women entrepreneurs or not can be judged only by examining the significant values of the parameters. The technical inefficiency model can be specified as in Equation 4.

$$TE_i = \delta_0 \quad + \quad \sum_{j=1}^{m} \delta_j H_{ij} + \varepsilon_i \qquad \text{Equation 4}$$

where H is a vector of exogenous variables and the parameters of this equation are estimated by OLS. The statistical significance of the δ's enables us to identify the policy variables through which the technical efficiency of the women entrepreneurs can be raised.

4. METHODOLOGY

The data collection process required a preliminary survey in order to construct the sampling frame and draw sample. A pilot survey was conducted to identify the population of women food processors located within the municipality of Cape Coast and its neighbouring towns in 2002. One hundred and twenty six women food processors were identified for this purpose. Their names and locations were entered on slips. Lottery method was used to select the sample of forty women food processors.

Research assistants who were very proficient in Fante were selected and trained for one week so that they could interpret the questionnaire to the women entrepreneurs. The questionnaire was validated through pilot survey, sampling procedures, and follow up survey. Before the final questionnaires were administered, pilot survey was again conducted on five respondents. The survey revealed some weaknesses in the structure of some of the questions in the original questionnaire. The questionnaire was therefore modified accordingly

and was administered by the research assistants. Statistical test for the validation of the questionnaire revealed at the 5% level of significance that we should go ahead for the collection of data. Information was collected on types of milling/grinding machines used in the food processing, value of output, physical quantities of inputs, human capital variables and institutional variables. There was a follow up survey to confirm some of the responses provided by the respondents.

Since the food processors produce differentiated products, we use the value of output instead of physical output as a dependent variable in the empirical estimation of production function. The inputs that are included in the production function are the expenditure on equipment, expenditure on electricity, expenditure on water and the man-hours worked. Technical efficiency of women entrepreneurs refers to their capabilities to manage resources in an efficient manner. The value of technical efficiency lies between zero and one. The most efficient women entrepreneur gets a value of one for technical efficiency. The less efficient women entrepreneurs get values ranging between zero and one.

The limited information maximum likelihood method is used to obtain estimates for the parameters of preferred frontier production function. The likelihood ratio test is used to test the appropriateness of stochastic frontier production function (which includes two error terms) in relation to the standard production function (which includes only one error term). Once it has been established that the stochastic frontier production function fits the data better, the distribution of technical efficiency is examined, which shows whether there is any scope in the improvement of technical efficiency of women entrepreneurs. Thereafter, the estimated technical efficiencies are regressed on the human-capital and institutional variables. The Ordinary Least Squares (OLS) method is used for the estimation of regression equations. The general model is reduced to the preferred model by deleting the insignificant variables. This model helps us in identifying the role of adoption of technology and other policy variables through which the technical efficiency of women entrepreneurs could be raised.

5. RESULTS

The maximum likelihood estimates of preferred frontier production function are indicated in Table 1. First of all it is important to note that the Likelihood Ratio test statistic is statistically significant at the 5% level of significance, which

implies that the frontier production function fits the data better than an average production function.[1] This point is also buttressed by significant Variance Ratio. It is evident from the estimated Cobb-Douglas frontier production function of women food processors that electricity, water, equipment and man-hours worked are found to be the significant determinants of value of output, with elasticity coefficients of 0.14, 0.09,0.60 and 0.11, respectively.[2] Since the sum of the elasticity of output with respect to the various inputs is less than one, which either suggests decreasing returns to scale or perhaps some missing explanatory variables (rent on land/shops and other materials) in the production function. The elasticity of labour with respect to output is the highest because labour is a crucial input in the food processing business and that shows the policy makers should concentrate on the labour input to increase the incomes of women food processors.

The distribution of technical efficiencies of women food processors is indicated in Table 2. The mean technical efficiency of the women food processors is 64.5%. Most of the women food processors are operating at efficiency levels above 51%, with the least efficient women food processor operating at an efficiency level of 13.9% and the most efficient women food processor operating at an efficiency level of 91.3%. The distribution of technical efficiency shows there is ample scope for the improvement of technical efficiency of women food processors in Cape Coast and its neighbouring towns.

Our findings for technical efficiency of women food processors in Cape Coast and its neighbouring towns are very similar to the findings of Admassie and Asfaw (1997), Croppenstedt and Muller (1998), Njikam (1998), Weir (1999), Ajibefun and Daramola (1999), Obwona (2000), Bhasin and Akpalu (2001), and Bhasin (2002). Admassie and Asfaw (1997) have observed that the mean profit efficiency of farmers in Ethiopia is 54 percent. Croppenstedt and Muller (1998) have noted that the average farm specific efficiency of farmers in Ethiopia ranges from 51 to 76 percent depending on the assumed distributional form of the one-sided error. Njikam (1998) has observed that the technical efficiency of electrical firms in Cameroon varied from 50.98% to 94.39% with a mean efficiency level of 81.91% before trade liberalisation. It remained between 38.85% and 95.76% with a mean efficiency level of 76.87% after trade liberalisation. Weir (1999) has observed that the farm-level efficiency in Ethiopia is approximately 55%. Ajibefun and Daramola (1999) have observed that the technical efficiency of block makers in Nigeria varied between 19.0% and 85.0% with a mean efficiency level of 72.0%. The technical efficiency of

metal fabricators in Nigeria was found to lie between 27.0% and 92.0% with a mean technical efficiency of 80.0%.

The technical efficiency of saw millers in Nigeria varied between 30.0% and 90.0% with mean technical efficiency of 78.0%. Obwona (2000) has observed that the technical efficiency of tobacco growers in Uganda varied between 44.8% and 97.3% with mean technical efficiency level of 76.2%. Bhasin and Akpalu (2001) have observed that the technical efficiency of women hairdressers in Cape Coast, Ghana varied between 39.3% and 94.4% with mean technical efficiency of 75.7%. The technical efficiency of women dressmakers varied between 41.9% and 99.0% with mean technical efficiency of 83.4%. On the other hand, technical efficiency of male wood processors varied between 69.7% and 100.0% with mean technical efficiency of 89.1%. Bhasin (2002) has observed that the technical efficiency of onion growers in the Upper East Region of Ghana varied between 65.6% and 97.1% with mean technical efficiency of 82.0%. The technical efficiency of pepper growers varied between 67.4% and 99.9% with mean technical efficiency of 88.7%. The technical efficiency of tomato growers varied between 12.8% and 100.0% with mean technical efficiency of 70.4%.

Table 1: Maximum Likelihood Estimates of Cobb-Douglas Frontier Production Function

Sub-sector Variables	Informal Food-Processing
Intercept[3]	1.4213*
	(0.3732)
Electricity	0.1458***
	(0.1223)
Water	0.0902***
	(0.0775)
Man-hours	0.6007*
	(0.0743)
Equipment	0.1130***
	(0.0893)
Variance Ratio	0.9094**
(γ)	(0.0656)
Total Variance(σ^2)	0.5046*
	(0.1457)
Log-Likelihood Function	-23.6950
Likelihood Ratio Test	8.1747**

Notes: 1.   The figures in the parentheses are the standard errors.
    2.*   indicates that the statistic is significant at 1% level of
       significance.
    **   indicates that the statistic is significant at 5% level of
       significance.
    ***   indicates that the statistic is significant at 10% level
       of significance.

Table 2: Distribution of Technical Efficiencies

Efficiency	Women Foods Processor	
	Number	%
11-20	2	5.0
21-30	0	0.0
31-40	1	2.5
41-50	4	10.0
51-60	7	17.5
61-70	6	15.0
71-80	13	32.5
81-90	5	12.5
91-100	2	5.0
TOTAL	**40**	**100.0**

MEAN   64.51%
MIN   13.9%
MAX   91.3%

Given a technology to transform physical inputs into outputs, some women food processors are able to achieve maximum efficiency of 91.3%, while the others are technically inefficient. This discrepancy could be because the latter group does not have adequate technical knowledge compared to the first group. On the other hand, this discrepancy may exist because of human capital, institutional and socio-economic variables (Kalirajan and Shand, 1989, Bhasin and Akpalu, 2001, Bhasin, 2002). The computed technical efficiencies are modelled to depend on certain human-capital and institutional variables. We expect to observe a negative relationship between the age of operator, number of children and technical efficiency. On the other hand, we expect to observe a positive relationship between level of education, business experience, leisure time, health status, access to credit, adoption of new and efficient technologies at work place and technical efficiency.

First, we estimate the general model with all the human capital and institutional variables. Due to the problem of multicollinearity, coefficients of some of the variables are insignificant and bear incorrect signs. These variables are deleted in stages from the regression equation to arrive at the preferred model. However, it should be mentioned that dropping of multi-collinear variables could reduce the biasness of the estimated coefficients. The estimated coefficients of the general model for the women food processors are presented in the Appendix. The estimates for the preferred model are given in Table 3. The significant determinants of technical efficiency of women food processors are level of education, number of children, access to credit, and adoption of new and efficient technologies at work place. While interpreting the results, we should keep in mind that only one variable changes and other variables are kept constant.

Level of education of the women food processor is positively related to her technical efficiency. One additional year of schooling enhances the technical efficiency of women food processors by 4.6%. Education enhances the stock of human knowledge and this consequently increases her efficiency. Educated women should be encouraged to open food-processing businesses. The number of children staying with the women food processor has a negative impact on her technical efficiency. One additional child staying with the women food processor reduces her technical efficiency by 2.2%. Looking after many children will make the women food processor more tired and can make her less efficient. Women food processors should try to limit the sizes of their families by adopting family planning methods and taking less social responsibilities.

We have observed that those women food processors that have better access to credit are relatively more efficient. Additional loan of one million cedis (100 Ghana cedis) enhances the technical efficiency of women food processors by 5.0%. If the amount of loan is utilised for the purchase of media equipment (radio, television etc.) through which the women food processor can acquire more information and ultimately manages the resources efficiently then we can say that the access to credit can influence her technical efficiency. Since the amount of credit matters for her efficiency, the government should try to increase the flow of funds through the various suppliers of informal and formal credit. Adoption of technology at the work place has a positive impact on the technical efficiency of women food processors. Adoption of one new and efficient food grinding machines at the work place increases the technical efficiency of women food processors by 1.9%. Those institutions that promote the development and adoption of new technologies should popularise new and efficient food grinding machines among the women food processors so that their efficiency could be raised. The value of R^2 indicates that the estimated regression equation is a good fit. The significant value of F indicates that the independent variables that are considered in this study are jointly significant.

Table 3: Determinants of Technical Efficiencies.

Sub-sector Variables	Informal Food-Processing
Intercept	0.4796*
	(0.1490)
Level of Education	0.0460
	(0.0106)
Number of Children	-0.0220**
	(0.0095)
Credit[4]	0.00005
	(0.00001)
Technology at Workplace	0.0190**
	(0.0078)
	0.97
F-Statistic	324.11*

Notes: 1. The figures in the parentheses are the standard errors.
2. * indicates that the statistics are significant at 1% level of significance.
3. ** indicates that the statistics are significant at 5% level of significance.

Our findings with regard to the determinants of technical efficiency are in conformity with some of the findings of Weir (1999), Ajibefun and Daramola (1999), Obwona (2000), Weir and Knight (2000), Bhasin and Akpalu (2001), and Bhasin (2002). Weir (1999) has observed that increased schooling reduces inefficiency of farmers in Ethiopia. Ajibefun and Daramola (1999) have shown that the significant determinants of technical efficiency of block-makers and saw-millers in Nigeria are age of operator, level of education, business experience, and number of employees and level of investment. The significant determinants of technical efficiency of metal fabricators in Nigeria are age of business, level of education, business experience and number of employees. Obwona (2000) has shown that the significant determinants of the efficiency of tobacco growers in Uganda are the family size, level of education, health status, hired workforce, and credit accessibility, fragmentation of land and extension services. Weir and Knight (2000) have observed for farmers in Ethiopia that a one year increase in average schooling attained in the household reduces measured farm inefficiency in the production of cereal crops by 2.1 percentage points.

Bhasin and Akpalu (2001) have shown that the significant determinants of technical efficiency of women entrepreneurs of Cape Coast, Ghana, engaged in hairdressing are age of operator, business experience, credit and contact with the lender. In dressmaking, the significant determinants of technical efficiency of women entrepreneurs are age of operator, level of education and credit. However, the significant determinants of technical efficiency of male wood processors are age of operator, business experience, training programmes, credit and contact with the lender. Bhasin (2002) has shown that the significant determinants of technical efficiency of onion growers in the Upper East Region of Ghana are farm experience, distance of the farm from the house of the farmer and extension services. The significant determinants of technical efficiency of pepper growers are age of the farmer, distance of the farm from the market, and extension services. On the other hand, the significant determinants of technical efficiency of tomato growers are age of the farmer, level of education, distance of the farm from the house of the farmer, and soil fertility management practices. The present study has identified two new significant determinants of technical efficiency of women food processors and these are the number of children and adoption of new and efficient technologies at work place.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

The Cobb-Douglas frontier production function is found to be the most appropriate production function for the women food processors. Electricity, water, equipment and man-hours worked are found to be the significant determinants of value of output. The elasticity of labour with respect to output is noticed to be the highest. The distribution of technical efficiency shows that there is ample scope for the improvement of technical efficiency of women food processors because only 5% of women food processors have their technical efficiency which is above 91%. The technical efficiency can be improved by concentrating on its significant determinants. The significant determinants of technical efficiency of women food processors are level of education, number of children, access to credit, and adoption of new and efficient technologies at work place. Educated women should be encouraged to open more food-processing enterprises. Keeping in view that number of children is a significant determinant of technical efficiency; policies should be designed to reduce the number of children born by educated women food processors such as by providing knowledge about the family planning methods. Access to credit to women entrepreneurs should be increased so that they can adopt new and efficient technologies at the work place.

ENDNOTES

1. The average production function assumes only one error term that is normally distributed.

2. The inclusion of rent on land/shops and materials as inputs besides electricity, water, man-hours and equipment in the production function yielded inconsistent estimates and that is why these two inputs were excluded from the production function. Moreover, since the trans-log production function yielded inconsistent estimates, the Cobb-Douglas production function was selected for analysis.

3. The intercept takes care of the omitted variables.

4. The value of the coefficient of credit is low because it is expressed in thousands of cedis.

REFERENCES

Adekanye, T. (1985) "Innovation and Rural Women in Nigeria: Cassava Processing and Food Production", in Ahmed, I. (ed). *Technology and Rural Women (ILO)*, George Allen and Unwin, London.

Admassie, A. and Asfaw. A. (1997) *The Impact of Education on Allocative and Technical Efficiency of Farmers: The Case of Ethiopian Smallholders,* Department of Economics, Addis Ababa University, Addis Ababa, Ethiopia.

Afriat, S. (1972). "Efficiency Estimation of Production Function.", *International Economic Review*, 13, pp. 569-598.

Aigner, D., Lovell, C. and Schmidt. P. (1977) "Formulation and Estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics*, 6, pp. 21-37.

Ajibefun, I. and Daramola. G. (1999) *Efficiency of Micro-enterprises in the Nigerian Economy*, Final Report, African Economic Research Consortium Workshop, Nairobi, Kenya.

Battese, G. and Coelli. T. (1995) "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data", *Empirical Economics,* 20, pp. 325-332.

Bauer, W. (1990) "Recent Developments in the Econometric Estimation of Frontiers", *Journal of Econometrics*, 46, pp. 39-56.

Berham, J. (1996) "The Impact of Health and Nutrition on Education", *The World Bank Research Observer*, 11(1), pp.

Bhasin, V. and Akpalu. W. (2001) "Impact of Micro-finance Enterprises on the Efficiency of Micro-enterprises in Cape Coast", *IFLIP Research Paper*, 5, pp. 1-53.

Bhasin, V. (2002) *Agricultural Productivity, Efficiency, and Soil fertility Management Practices of Vegetable Growers in the Upper East Region of Ghana*, SADAOC Foundation Project Report.

Boserup, E. (1970) *Women's Role in Economic Development*, Allen and Unwin, London.

Bouis, H. (1990) "Evaluating Demand for Calories for Urban and Rural Population in the Philippines: Implications for Nutrition under Economic Recovery", *World Development*, 18(2), pp. 281-299.

Charnes, A., Cooper, W., Lewin, A. and Seiford. L.(1994) *Data Envelopment Analysis: Theory, Methodology, and Applications*, Kluwer Publishers, Boston.

Coelli, T. (1994) *A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation*, Department of Econometrics, University of New England, Armidale, Australia (mimeographed).

Coelli, T. (1995) "Recent Developments in Frontier Modelling and Efficiency Measurement", *Australian Journal of Agricultural Economics*, 39, pp. 219-245.

Cornwell, C, Schmidt, P. and Sickles. R.(1990) "Production Frontier with Cross-section and Time-series Variations in Efficiency Levels", *Journal of Econometrics*, 46, pp. 185-200.

Croppenstedt, A. and Demeke. M. (1997) "An Empirical Study of Cereal Crop Production and Technical Efficiency of Private Farmers in Ethiopia: A Mixed Fixed-random Coefficients Approach", *Applied Economics*, 29, pp. 1217-1226.

Croppenstedt, A., and Muller. C. (1998) *The Impact of Health and Nutritional Status of Farmers on their Productivity and Efficiency: Evidence from Ethiopia.*, Centre for the Study of African Economies, Oxford University, Oxford.

Diewert, W. and Parkan.C. (1983). "Linear Programming Tests of Regularity Conditions for Production Function.", in Eichorn, W., Henn, R., Neumann, K. and Shephard. R. (eds), *Quantitative Studies on Production and Prices*, Physica-verlag, Vienna, Austria.

Elson, D. and Evers, B. (1997) "Concepts and Sources", *Gender Aware Country Economic Reports Working Papers No. 1,* The Graduate School of Social Sciences, University of Manchester, Manchester.

Farrell, M. (1957) "The Measurement of Production Efficiency", *Journal of the Royal Statistical Society Series A (General)*, 120, pp. 253-281.

Fried, H., Lovell, C. and Schmidt. S. (1993) *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press, Oxford.

Fogel, R. (1994) *New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health, Mortality and the Process of Aging*, NBER Working Paper, No. 26, Wshington, D.C.

Forsund, F., Lovell, C. and Schmidt. P. (1980) "A Survey of Frontier Production Functions and their Relationship to Efficiency Measurement", *Journal of Econometrics*, 13, pp. 5-25.

Gazier, B. (1992) *Labour and Employment Economics*, Precis Dalloz, Paris, France.

Ghana Statistical Service. (2005) *Population Data Analysis Report*, Volume 2, Accra, Ghana.

Ghana Statistical Service. (2007) *Pattern and Trends of Poverty in Ghana 1991-2006*, Accra, Ghana.

Greene, W. (1988) "A Gamma Distributed Stochastic Frontier Model", *Journal of Econometrics*, 46, pp. 141-63.

Haddad, L. and Kennedy. E. (1992) *The Multiple Roles of Women: Influences on Food Security and Nutrition*, UNICEF Cornell Lecture Series on Food and Nutrition, Paris, France.

Hanoch, G. and Rothchild. M. (1972) "Testing the Assumptions of Production Theory: A Non-parametric Approach.", *Journal of Political Economy*, 80, pp. 256-275.

Huang, C. (1984) "Estimation of Stochastic Frontier Production Functions and Technical Inefficiency via the EM Algorithm", *Southern Economic Journal*, 50(3), pp. 847-856.

International Labour Organisation (ILO). (1994) *The Problem of Women's Access to Employment in Africa*", Fourth International Conference on Women, Geneva.

Joll, C., Mc Nabb, R. and Shorey. J. (1993) *Developments in Labour Market Analysis*, George, Allen and Unwin, London.

Jondrow, J., Lovell, C.., Meterov, I. and Schmidt.P. (1982) "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model", *Journal of Econometrics*, 19, pp. 233-238.

Kalirajan, K. and Obwona. M. (1994) "Frontier Production Function: The Stochastic Coefficients Approach.", *Oxford Bulletin of Economics and Statistics*, 56, pp. 85-94.

Kalirajan, K. and Shand. R. (1989) "A Generalised Measure of Technical Efficiency", *Applied Economics*, 21, pp. 25-34.

Kumbhakar, S. (1990) "Production Frontiers, Panel Data and Time Varying Technical Inefficiency", *Journal of Econometrics*, 46, pp. 201-211.

Lachaud, J. (1996) *Women and the Urban Labour Market in Sub-Saharan Africa*, Montesquieu University Bordeaux IV, Research Series 1, Bordeaux, France.

Lee, L. (1983) "On Maximum Likelihood Estimation of Stochastic Frontier Production Models", *Journal of Econometrics*, 23, pp. 269-74.

Meeusen, W. and Van den Broeck. J. (1977) "Efficiency Estimation from Cobb-Douglas Production Function with Composed Error", *International Economic Review*, 18, pp. 435-444.

Njikam, O. (1998) "Trade Liberalisation and Productive Efficiency of Cameroon Electrical Firms", *African Journal of Economic Policy*, 5(1), pp. 21-46.

Njikam, O. (2000) *Trade Reform and Efficiency in Cameroonian Manufacturing Industries*, Final Report, African Economic Research Consortium, Nairobi, Kenya.

Obwona, M. (1995) *Production Frontiers and Efficiency Measures: Concepts and Applications*, Doctor of Philosophy Dissertation, Australian National University, Canberra, Australia.

Obwona, M. (2000) *Determinants of Technical Efficiency Differentials among Small and Medium Scale Farmers in Uganda: A Case of Tobacco Growers*, *Final Report*, African Economic Research Consortium (AERC) Workshop, Nairobi, Kenya.

Okine, V. (1989) *The Impact of Informal Sector on the Economy: The Survival Strategies of Poor Families and the Role of Women Therein*, UNESCO, Paris, France.

Psacharopolous, G. and Tzannlos. Z. (1989). "Female Labour Force Participation: An International Perspective", *World Bank Research Observer*, 4(2).

Schmidt, P. (1986). "Frontier Production Functions", *Econometric Reviews*, 4, pp. 289-328.

Schmidt,P.and Lovell. C (1979) "Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontiers, *Journal of Econometrics*,9, pp. 343-366.

Schmidt, P. and Sickles. R. (1984) "Production Frontiers and Panel Data", *Journal of Business and Economic Statistics*, 2(4), pp. 369-373.

Schultz, P. (1997) "Assessing the Productive Benefits of Nutrition and Health: An Integrated Human Capital Approach", *Journal of Econometrics*, 77, pp.

Soetan, R. (1996) *Technology and Female-owned Businesses in the Urban-informal Sector of South-West Nigeria*, ATPS, Working Paper, No. 11, Nairobi, Kenya.

Stamp, P. (1986). *Technology, Gender and Power in Africa*, IDRC, Ottawa, Canada.

Trager, L. (1987). " A Re-examination of the Urban Informal Sector in West Africa", *Canadian Journal of African Studies*, 21(2), pp. 239-255.

UNIFEM. (1997) *A Women's Development Agenda for the 21 st Century*", United Nations International Fund for Women (UNIFEM), Washington, DC.

UNDP. (1997). *Human Development Report*, Oxford University Press, New York.
Varian, H. (1985). "Non Parametric An alysis of Optimising Behaviour with Measurement Error", *Journal of Econometrics*, 30, pp. 445-458.

Waldman, D. (1984) "Properties of Technical Efficiency Estimators in the Stochastic Frontier0 Model", *Journal of Econometrics*, 25, pp. 353-364.

Weir, S. (1999) *The Effects of Education on Farmer Productivity in Rural Ethiopia*, Working Paper Series, No. 7, Centre for the Study of African Economies, University of Oxford, Oxford.

Weir, S., and Knight. J. (2000) *Adoption and Diffusion of Agricultural Innovations in Ethiopia:*

The Role of Education, Working Paper Series, No. 5, Centre for the Study of African Economies, University of Oxford, Oxford

Whitehead, A. (1981) *A Conceptual Framework for the Analysis of the Effects of Technological Change on Rural Women*", International Labour Organisation (ILO) Working Paper, Geneva.

Whitehead, A. (1985) "Effects of Tec hnological Change on Rural Women: A Review of Analysis and Concepts", in Ahmed, I. (ed.) *Technology and Rural Women: Conceptual and Empirical Issues*, George Allen and Unwin, London.

World Bank. (1995) *Advancing Gender Equality: From Concept to Action*, Washington, D.C., U.S.A.

Appendix: General Model Estimates for Technical Efficiency

Sub-sector Variables	Informal Food-Processing
Intercept	0.5042*
	(0.1775)
Age of Operator	0.0003
	(0.0008)
Business Experience	0.0011
	(0.0015)
Level of Education	0.0057
	(0.0166)
Health Status	-0.0084
	(0.0329)
Number of Children 1	-0.0251**
	(0.0112)
Credit	0.00006*
	(0.00001)
Leisure Time	-0.0007
	(0.0008)
Technology at Work Place	0.0201**
	(0.0082)
R^2	0.97
F-Statistic	149.17*

Notes: 1. The figures in the parentheses are the standard errors. 2. * indicates that the statistic is significant at 1% level of significance.
3. ** indicates that the statistic is significant at 5% level of significance.