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Technical Efficiency Analysis of the Ethiopian Brewery Industries

BY
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ABSTRACT

This study aims at determining the level of technical efficiency of the Ethiopian brewery industries overtime using stochastic frontier production function model. All the parameters of the frontier function and the inefficiency model have been estimated simultaneously using maximum likelihood estimation.

The usefulness of the frontier approach to the measuring efficiency of industries is twofold. Firstly, it provides managers of the firms with answers to the questions regarding cost minimization, organization and distribution systems. Secondly, frontier methodology offers guidance to regulators and policy makers as for solving and mitigating problems in particular industry and economy in general.

The study considered five brewery industries over the period of 2006-2010 using firm level panel data. The empirical result indicates that the Translog functional form with maximum likelihood estimation better explains the production behavior of the brewery industries .The study estimates the average technical efficiency of the brewery industries is 80%.Therefore, the results indicate that there is a great potential exists for brewery industries to further increase the value added by 20% using the available input, technology and efficiency improvement, thereby reducing the cost of production. It's interesting to note that out of the five technical inefficiency factors included in the translog model there were only two factors (export and investment intensity) which had a significant effect on technical inefficiency. The study further identifies that the mean efficiency of brewery industries vary among the industries and year-wise mean seems to be unstable during the study period. Therefore it invites further reform, competition and continued efforts to update technologies and equipment are required in pursuit of efficiency in the brewery industries. In order to effectively utilize the potential of the industries, efforts have to be made in improving investment intensity, export intensity, infrastructural and institutional development, and availability of updated marketing information system. The creation of conducive business environment enhances the industries development and promotes the competence in the global market competition.

Keywords: Brewery industries, stochastic production function, technical efficiency

Chapter one

1. Introduction

Beer consumption in developing countries is often seen as one revealing (if crude) proxy for gauging the strength of economic activity. If beer sales are high and rising, incomes and economic activity are presumably growing strongly while the reverse should be true if beer sales are flat or falling (Access capital research, 2010).

Ethiopia has potential for the development of the industrial growth due to its natural resource bases. However, the industrial sector has not been adequately developed and its contribution to the national gross domestic product (GDP) and employment has been limited. According to National Accounts Statistics Estimate (2002), Ethiopian Fiscal year the industrial sector has 23% share of GDP and it grew by 20% in the year 2009/2010. The manufacturing sector has 43% share of the industrial sector and the brewery industry is one of the six main industries in this sector. According to the statistical Abstract of 2007 produced by CSA, breweries in Ethiopia produced 1.56 million hectoliter of beer during 2006 and this represented 37% of all beverage produced by commercial producers. It was second to soft drinks which produced 2 million hectoliter during the same period and this represented 48%. The rest included wine and other alcoholic spirits.

In Ethiopia growth in beer consumption has been growing high 24 percent per year, roughly double the average annual growth rate in real GDP. Even after such a rapid increase, however, per capita beer consumption in Ethiopia is still only a fraction of the level seen in other African countries according to access capital estimates (2010).

Ethiopia's beer industry is currently comprised of five major breweries plants. These are Meta abo, Harar, Bedele, BGI and Dashen. The first three are state owned enterprises where as the last two are owned by foreign investor and a local private producer respectively.

Ethiopia beer industry has seen much activity in recent years including a surge in demand associated with increased urbanization, population growth, rising incomes. From a level of just 1 million hectoliters in 2003/04, beer production has risen to nearly 3.1 million hectoliters by 2008/09, giving an estimated average growth of around 24% per year (according to access capital research 2010). With estimated consumption of 3.1 million hectoliters and a population of

near 80 million, annual consumption per head is only around 4 liters in Ethiopia, According to (Access capital research, 2010).

The business environment in Ethiopia is very favorable and the government support to those who want to build breweries plant is encouraging. The demand-Supply gap for beer is big, there will be a significant unsatisfied demand for beer for years to come as the economy is expected to grow in double digits in the near future.

In contrast, during Derg times with supply of only limited brand at present the brewery industry offers a variety of brands and improve quality of beer. Export sales according to official statistics of ministry of trade varied from year to year about 6-7% of total production. Major exporters were St. George which accounted over 90% of total exports.

Therefore, under this study, we discuss the firm level technical efficiency of the existing five brewery plant in Ethiopia. The study will use partial analysis by selecting the different variables. The study would help researchers and policy makers to understand the technical efficiency of the brewery plant and factor affecting the technical efficiency.

Recent growth rates for beer consumption have amounted to around 0.8 time's nominal GDP growth and 1.8 times real GDP growth over the past five years (Access capital research, 2010). Encouraged by these factors some investors have decided to enter the market and more are still planning to do so. Unfortunately, investing in brewery is capital-intensive undertaking and needs specialized knowledge and skills.

However there has been a widespread discussion about lack of adequate technical efficiency in brewery industry in Ethiopia .So in this paper, we need to assess the efficiency of the brewery plant to fill the gap between the demand and supply. There is no any specific research that was done related to this technical efficiency. These initiate, me to analysis the five -brewery industry that is found in Ethiopia by analyzing their efficiency.

The General objective of this study is to measure the technical efficiency of the brewery industries in Ethiopia.

Specific objective:

- To identify the determinant that affects the technical inefficiency of brewery industry in Ethiopia.
- To examine whether the efficiency of brewery industries was time variant or invariant.
- To evaluate the technical efficiency of state owned and private owned brewery industry.

The study hypothesized, currently all brewery industries in Ethiopia are technically efficient. Thus the paper try to test by formulating the null hypothesis that the existence of no technical inefficiency.

The major expected beneficiaries of the findings of this study can be investor's that participate in brewery industry, new entrants in the business and the regulatory body. The study can serve as input for breweries to objectively identify their drawbacks. Hence they can know the different variables affecting the efficiency and utilize the resources available efficiently. On the other hand the government can use the result of this study to identify the inefficient state owned enterprises. To the best of this researcher there is no other research work done on the efficiency of the brewery plants, so that the paper will help as an input for further researchers.

This study analyses the five brewery factories efficiency by selecting variables based on from different literature but it is difficult to get sufficient data that could be used to conduct the study. To get sufficient good quality data, it is necessary to get enough financial resources and longer period of time; lack of these resources can limit the scope and quality of the study.

Chapter two

Literature review

This section identifies and describes the various approaches in the theoretical and empirical literature that are used to assess the efficiency of firms. The emphasis of the discussion will be on methods that are based on parametric and non-parametric approaches.

2.1 Definition Efficiency

Efficiency of an institution was first analyzed by Farrell(1957) ,he proposed the concept of economic efficiency to represent total efficiency in an institution.

There are two types of efficiency

- 1) Technological efficiency
- 2) Allocative efficiency

1) **Technical efficiency:** In microeconomics of production is defined as the maximum attainable level of output for a given level of factors of production given the range of alternative technology available (Ellis, 1993).

Alternatively the technical efficiency of a firm may be defined as the ratio of its observed output to that which could be produced by the fully efficient firm given the same input quantities.

2) **Allocative efficiency** is defined as the ability of a firm to maximize profit by equating marginal revenue product of input to their respective marginal cost.

The concept of efficiency can also be viewed with respect to productivity:

- According to coelli et al (1998) productivity is commonly defined as the ratio of a volume of output to a volume of inputs used.
- Measuring productivity is how best the inputs are utilized to produce certain level of output or how effectively these inputs are utilized over a period of time.

2.2 Theoretical review

The concept on measuring the efficiency of an institution was first proposed by Farrell (1957).

In the immediate post-war years there was a general interest in growth and productivity, and Solow's most influential paper on these issues within a macro setting appeared in 1957. At the same time Farrell laid the foundation for new approaches to efficiency and productivity studies at

the micro level, involving new insights on two issues: the definition of efficiency and productivity and the benchmark technology and the efficiency measures.

The fundamental assumption was the possibility of inefficient operations, immediately pointing to a frontier production function concept as the benchmark, as opposed to a notion of average performance underlying most of the econometric literature on the production function up to the time of the seminal contribution.

The contribution of Farrell was path breaking as to three aspects such as

- (i) Efficiency measures were based on radial uniform contractions or expansions from inefficient observations to the frontier.
- (ii) The production frontier was specified as the most pessimistic piecewise linear envelopment of the data,
- (iii) The frontier was calculated through solving systems of linear equations, obeying the two conditions on the unit isoquant.

The new aspect of Farrell was to offer a decomposition into technical efficiency price (or allocative) efficiency and overall efficiency at the micro level of a firm (or production unit). The radial contraction/expansion connecting inefficient observed points with (unobserved) reference points on the production frontier as the basis for the measures is the hallmark, and due to fundamental duality between production and cost functions identical measures can also be defined using the latter.

According to Farrell et al(1957), Technical efficiency is defined as inputs needed at best practice to produce observed outputs relative to observed quantities, keeping observed input ratios, where as Price efficiency is defined as costs of producing observed output at observed factor prices assuming technical efficiency, relative to minimized costs at the frontier. Farrell also defined Overall efficiency as costs of producing observed output if both technical efficiency and price efficiency are measured relative to observed costs. In the choice of a production frontier benchmark, Farrell adopts a most practical approach, starting with engineering considerations and ending up with recommending observed best practice. Inspired by the activity analysis of Koopmans et al, (1951) his contribution was to introduce a piecewise linear envelopment of the data as the most pessimistic specification of the frontier, in the sense of the function being as close to the observations as possible and to show how the frontier could be established by solving linear equations. Farrell himself points to Debreu's et al, (1951) concept of "coefficient

of resource utilization” as inspiration for his measure of technical efficiency. This has led some to adopt the name “Debreu –Farrell measures of efficiency” (Färe and Lovell et al, (1978), Färe, Grosskopf and Lovell et al, (1985), Russell et al, (1998)).

Generally Farrell’s efficiency measures are completely data-based, no specific functional form needed to be predefined & follow an input-oriented scheme. A detailed analysis of output-oriented efficiency measures can be found in Färe et al, (1985), Grosskopf and Lovell et al, (1994). Färe and Lovell et al, (1978) point out that, under constant return to scale (CRS), input-oriented and output-oriented measures of technical efficiency are equivalent. Such equivalence as Forsund and Hjalmarsson et al, (1979) and Kopp et al, (1981) state, ceases to apply in the presence of non-constant returns to scale. The analysis of allocative efficiency in an output-oriented problem is also treated in Färe et al, (1985), Grosskopf and Lovell et al (1994) and Lovell et al,(1993) from a revenue maximization perspective. Kumbhakar et al ,(1987), Färe, Grosskopf and Lovell et al,(1994) and Färe, Grosskopf and Weber et al, (1997) approach the analysis of allocative efficiency on the basis of profit maximization, where both cost minimization (input-oriented model) and revenue maximization (output-oriented model) are assumed.

From the end of the 1970s onwards, several techniques have been developed for efficiency analysis these techniques can be classified in different ways. The criterion followed here distinguishes between parametric and non-parametric methods that is, between techniques where the functional form of the efficient frontier is pre-defined or imposed a priori and those where no functional form is pre-established but one is calculated from the sample observations in an empirical way.

The single-input/output efficiency measure of Farrell is generalized to the multiple input/ output case and reformulated as a mathematical programming problem by Charnes, Cooper and Rhodes et al, (1978). Charnes, Cooper and Rhodes et al, (1981) named the method Data Envelopment Analysis.

The aim of this non-parametric approach to the measurement of productive efficiency is to define a frontier envelopment surface for all sample observations. This surface is determined by those units that lie on it, on the other hand, units that do not lie on that surface can be considered as inefficient and an individual inefficiency score will be calculated for each one of them. Unlike stochastic frontier techniques, Data Envelopment Analysis has no accommodation for noise, and

therefore can be initially considered as a non statistical technique where the inefficiency scores and the envelopment surface are 'calculated' rather than estimated Murillo-Zamorano et al, (2004).

The model developed in Charnes, Cooper and Rhodes et al (1978), known as the CCR model, imposes three restrictions on the frontier technology: Constant returns to scale, convexity of the set of feasible input-output combinations; and strong disposability of inputs and outputs.

The CRS restriction assumes that all decision making unit (DMU) under analysis are performing at an optimal scale. In the real world, however, this optimal behavior is often precluded by a variety of circumstances such as different types of market power, constraints on finances, externalities, imperfect competition, etc. In all this case, the CRS specification given by Charnes, Cooper and Rhodes et al, (1978) yields misleading measures of technical efficiency in the sense that technical efficiency scores reported under that set of constraints are biased by scale efficiencies.

This important shortcoming is corrected by Fare, Grosskopf and Lovell et al, (1983) Byrnes, Fare and Grosskopf et al, (1984) and Banker, Charnes and Cooper et al, (1984) who extended DEA to the case of Variable Returns to Scale (VRS). Variable Returns to Scale are modeled by adding the convexity constraints. This final constraint simply guarantees that each DMU is only compared to others of similar size. This mode of operation avoids the damaging effect of scale efficiency on the technical efficiency scores.

So far, all the preceding analysis has been developed in terms of input-oriented models. However, a DEA model, besides being input oriented, may also be output oriented or even unoriented. In oriented models, unlike in unoriented models, one set of variables, either inputs or outputs, precedes the other in its proportional movement toward the efficient frontier. Input oriented models try to maximize the proportional decrease in input variables while remaining within the envelopment space; while output oriented models will maximize the proportional increase in the output vector. The choice of one or the other model might be based on the specific characteristics of the data set analyzed Murillo-Zamorano et al, (2004).

The main advantage of DEA is the fact that the estimation is based on data set of inputs and outputs which are often available, moreover making an assumption of equal prices of inputs allow an aggregation of all inputs in to the total costs which is too easily available from the

financial statement Simar and Zelenyuk et al, (2003). one of the main drawbacks of non-parametric techniques is their deterministic nature.

This is what traditionally has driven specialized literature in this issue to describe them as non-statistical methods. Nevertheless, recent literature has shown it is possible to define a statistical model allowing for the determination of statistical properties of the non-parametric frontier estimators. In this respect, Grosskopf et al, (1996) first provides a good and selective survey of statistical inference in nonparametric, deterministic, linear programming frontier models.

In an attempt to accommodate econometric techniques to the underlying economic theory a wide and challenging literature related to the estimation of frontier functions has proliferated over the last three decades. These attempts can be classified into two main groups according to the specification of the error term, namely deterministic and stochastic econometric approaches. Moreover, any specification problem is also considered as inefficiency from the point of view of deterministic techniques. On the contrary, stochastic frontier procedures model both specification failures and uncontrollable factors independently of the technical inefficiency component by introducing a double-sided random error into the specification of the frontier model.

The deterministic econometric approach employs the technological framework previously introduced by mathematical programming approaches. With an econometric formulation, it is possible to estimate rather than 'calculate' the parameters of the frontier functions Murillo-Zamorano et al, (2004).

Additionally, statistical inference based on those estimates will be possible. Several techniques such as Modified Ordinary Least Squares Richmond et al,(1974), Corrected Ordinary Least Squares. Gabrielsen et al, (1975) and Maximum Likelihood Estimation Greene et al, (1980) have been developed in the econometric literature in order to estimate these deterministic-full frontier models.

Unlike mathematical programming approaches, the deterministic econometric models accommodate economic efficiency as an explicative factor for the output variations, but still sacrifice the analysis of random shocks. Therefore, neither goal programming models nor deterministic econometric approaches provide accurate measures of the productive structure. So, in the interest of brevity and given that none of the above techniques is being really used in current literature, next focus on an alternative econometric approach that overcomes the

mentioned drawbacks and has become the most popular and widely used parametric approach for the measurement of economic efficiency, namely stochastic frontier models.

Murillo-Zamorano et al, (2004), Aigner, Lovell and Schmidt et al, (1977), Meeusen and van den Broeck et al, (1977) and Battese and Corra et al (1977) simultaneously developed a Stochastic Frontier Model (SFM) that, besides incorporating the efficiency term into the analysis (as do the deterministic approaches) also captures the effects of exogenous shocks beyond the control of the analyzed units by using composite error term.

The only difference between the two models was the assumption of the distribution of the one sided error term. Meeusen and van den Broeck et al (1977) assumed an exponential distribution to U , whereas Aigner, Lovell and Schmidt et al, (1977) used both half-normal and exponential distributions. There have also been different distributional forms suggested in the literature, such as the truncated normal (Stevenson et al, (1980)) and the two-parameter gamma (Greene et al, 1990).

A further classification of frontier models can be made according to the tools used to solve them, namely the distinction between mathematical programming and econometric approaches. The deterministic frontier functions can be solved either by using mathematical programming or by means of econometric techniques. The stochastic specifications are estimated by means of econometric techniques only (Murillo-Zamoraano et al, (2004)).

Most of the literatures related to the measurement of economic efficiency have based their analysis either on any of the above parametric or non-parametric methods. The choice of estimation method has been an issue of debate, with some researchers preferring the parametric (Berger et al, (1993) and others the nonparametric (Seiford and Thrall et al, (1990) approach. The main disadvantage of non-parametric approaches is their deterministic nature. Data Envelopment Analysis, for instance, does not distinguish between technical inefficiency and statistical noise effects. On the other hand, parametric frontier functions require the definition of a specific functional form for the technology and for the inefficiency error term. The functional form requirement causes both specification and estimation problem.

2.3 Empirical review

In empirical literature the stochastic frontier application is predominant. Until recently, most of the empirical applications in the literature measuring technical efficiency using stochastic frontier production function approach have been in agricultural economics and operational research (mainly dealing with state-owned enterprises, non-profit organizations and the banking sector). Examples from the agricultural economics literature include Sidhu et al (1974) on the efficiency of wheat production in India. Examples of the application of technical efficiency analysis on state-owned enterprises include, Bhattacharyya et al, (1994) studying the technical efficiency of water utilities in the US.

The stochastic frontier production function can be specified as Cobb-Douglas, Constant Elasticity of substitution, Translog etc, functional forms.

Among the studies Kumbhakar et al, (1987) and Summa et al, (1987) conducted a study on the technical efficiency of 17 Finnish brewery plants using panel data (1955-1984) employing a production frontier approach method with a simple Cobb-Douglas (CD) production function form.

The distinguishing features of this study are that it includes three different phases, First phase (1955-1967) of relatively slow growth (4%), the second phase (1968-1972) of rapid growth (10%) and the third phase (1973-1984) of a slow growth (2%) with sharp increase in input prices. Another interesting institutional feature of the observation period is a gradual sharpening of competition as the regional monopoly of individual breweries was relaxed steep wise and eventually abolished in 1969. These features gives them a unique opportunity to study efficiency levels of the individual plant during these sub –periods and especially whether competition promote efficiency. The findings of this study showed that the last sub- period (1973-84) is associated with increasing competition and has on the average, higher plant efficiency. Finally it concludes that competitive pressure increases the efficiency of most of the plants.

Lundvall and Battese et al, (1998) using an unbalanced panel of 235 Kenyan manufacturing firms in the Food, Wood, Textile and Metal sectors and utilizing stochastic production frontier approach, estimated technical efficiency levels in Kenyan manufacturing industry and investigated whether technical efficiency is related to firm size and age. They found that the mean technical efficiency increases with size in all sectors and that there was no direct effect of age on efficiency.

Similarly Mahadevan et al, (2000) studied the technical efficiency of 28 three digit manufacturing industries in Singapore from 1975-94 using a Cobb-Douglas production function and stochastic production frontier approach. This study showed that on the average Singapore's manufacturing industries were operating at 73 per cent of their potential output level and showed that capital intensity and labour quality were important factors in determining the efficiency levels.

The other literature by Zahid and Mokhtar et al, (2007) utilized Cobb-Douglas stochastic production frontier in their study to estimate the technical efficiency of Malaysian small and medium manufacturing enterprise for the year 2002. The study considered 56 Manufacturing sub-sector including the leather sector. The average technical efficiency of all industries (which was 0.76) indicates about 24% of loss or inefficiency in the production process with similar result particularly for the leather sector. The study points out government intervention area that was required to further improve the operation of these enterprise.

Battese et al. (2001) use stochastic frontier models for firms in five different regions of Indonesia for the period 1990 to 1995 and find that there are substantial efficiency differences among the garment industry firms across the five regions.

Harris et al, (1991) used a frontier production function approach to estimate efficiency in Northern Ireland manufacturing sector for the year 1987-88 using cross section data from a survey of 140 manufacturing companies. The study found that the mean technical efficiency in Northern Ireland was approximately 80%. He also found that foreign-owned firms were more productive than the domestic firms and that increasing returns to scale were important.

In Ethiopia, a number of efficiency studies have been conducted but most of them concentrate in crop production sector of agriculture. To the best of this researcher there is no other research work done on the efficiency of the brewery plant. Among few researchers, Worku et al (2001), estimated the technical efficiency of leather industries using stochastic production frontier. He used panel data of 10 tanneries and 24 leather product industries to estimate technical efficiencies of the tanneries and leather product industries independently, the result indicated that tanneries and leather product industries are inefficient with declining trend. His test demonstrated that there are substantial efficiency difference among tanning industries. As we can see from the different examples of technical efficiency studies in the literature using the stochastic production frontier approach, there are various applications on manufacturing. Some

of the studies used cross-section data while others utilized panel data approach with the availability of data.

In this paper, the functional form of the production function for stochastic production frontier was specified as general Translog model. Specifications such as the Translog provide the opportunity to characterize the data in a more flexible way. However, the Translog estimates are likely to suffer from degrees of freedom and multicollinearity problems resulting in inefficient estimates (Coelli et al, 1998).

Chapter three

Methodology, Model Specification and Description of variables

3.1 Methodology

The different methods used to measure technical efficiency can be broadly classified in to two groups .The two approaches are non-parametric & parametric (Coelli eta al, 1998). Under non-parametric approach falls data envelopment analysis (DEA) which involves the use of econometric linear programming .The major advantage of the non-parametric approach is that it doesn't impose any functional form on the data, where as the main disadvantage is it's assumption of constant return to scale .

The parametric approach, even though it imposes functional form on the data, has a principal advantage due to its ability to characterize frontier technology in a simple mathematical form to accommodate non – constant returns to scale; furthermore the parametric methods can be classified in to deterministic and stochastic.

The deterministic method is based on the assumption that the production frontier is common to all firms with given level of output and that the inter-firm variation is attributable only to differences inefficiency (Coelli et al, 1998).

The stochastic frontier production function can be specified as Cobb-Douglas, constant elasticity of substitution, Translog, etc functional forms.

This study employs frontier production function to estimate technical efficiency of the brewery industries. The model specifies a stochastic frontier production function of the type proposed by Battese and Coelli (1995). In their model, a production frontier is specified which defines output as a function of a given set of inputs, together with technical inefficiency effects, which defines the degree to which firms fail to reach the frontier because of technical inefficiencies of production. The model specifies that these inefficiency effects are modeled in terms of other observable explanatory variables and all parameters are estimated simultaneously.

3.2 Model Specification

The stochastic production frontier for panel data model integrate the usual stochastic error term which is exogenous to the system and the firm level effects to be distributed as truncated normal random variables which are assumed to systematically vary over time. The generic representation of the model is as follows;

$$\ln(Y_{it})=X_{it}\beta+V_{it}-U_{it} \quad \text{For } i=1,2,3,\dots,N \text{ and } t=1,2,3,\dots,T \quad (1)$$

Where Y_{it} is the output of the firm at the time period; X_{it} denotes a (1xk) vector of log of input values; β is a (kx1) vector of unknown scalar parameters to be estimated; V_{it} are the usual random errors measuring the positive and negative effects of exogenous shocks assumed to be identically and independently distributed with mean zero and constant variance independently of the U_{it} ; U_{it} are non-negative random variables which are assumed to account for technical inefficiency in the model.

The summation of the two random variables V_{it} and U_{it} is expressed as e_{it} in which

$$\sigma_e^2 = \sigma_v^2 + \sigma_u^2 \quad \text{and} \quad \gamma = \sigma_u^2 / \sigma_e^2$$

Technical efficiency of the firm at time t is defined by:

$TE_{it} = \exp(-U_{it})$. It measures the extent to which a certain firm operates below the frontier drawn by the amount the most efficient firm among the sample firms produces given the similar working conditions and nature of input use.

Technical inefficiency effect can be assumed to be constant over time or can vary over time. The assumption of time invariant inefficiency considers that inefficiency of the industry has persistent nature and is time irresponsive. However, this study assumes that technical inefficiency changes overtime. The technical inefficiency effects as a function of time are defined as;

$$U_{it} = \{\exp[-\eta(t-T)]\} U_i \quad (2)$$

Where $i=1,2,\dots,N$ and $t=1,2,\dots,T$

U_i are non negative random variables associated with the technical inefficiency of production.

η is unknown scalar parameter to be estimated, which determines whether inefficiencies are time varying or time invariant; and U_{it} are assumed to be i.i.d are truncated at zero of the $N(0, \sigma_u^2)$ distribution.

If η is positive, then $-\eta(t-T) = \eta(T-t)$ is positive for $t < T$ and so $\exp[-\eta(t-T)] > 1$, which implies that the technical inefficiencies of industries decline over time. If η is zero, then the technical inefficiencies of industries remain constant. However, if η is negative, then $-\eta(t-T) < 0$ and thus the technical inefficiencies of industries increase over time.

The stochastic frontier production function can be specified as Cobb-Douglas, or Translog functional form.

The Cobb-Douglas functional form is defined as:

$$y_{it} = \beta_0 + \sum_{j=1}^4 \beta_j x_{jit} + V_{it} - U_{it} \quad (3)$$

The translog functional form which additionally considers the cross effects of inputs is defined as:

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \beta_3 x_{3it} + \beta_4 x_{4it} + \beta_{12} x_{1it} * x_{2it} + \beta_{13} x_{1it} * x_{3it} + \beta_{14} x_{1it} * x_{4it} + \beta_{23} x_{2it} * x_{3it} + \beta_{24} x_{2it} * x_{4it} + \beta_{34} x_{3it} * x_{4it} + \beta_{11} (x_{1it})^2 + \beta_{22} (x_{2it})^2 + \beta_{33} (x_{3it})^2 + \beta_{44} (x_{4it})^2 + V_{it} - U_{it} \quad (4)$$

Where $i=1,2,\dots,N$, index the number of industries ($N=5$). $t=1,2,\dots,T$ represent time period (five years are considered), y_{it} and x_{it} denote log of output and inputs respectively; y_{it} denotes the total net sales (at constant price) of the i^{th} brewery industry in the t^{th} period; x_{1it} represent fixed capital in birr; x_{2it} denotes wage and salary in birr; x_{3it} denotes fuel and energy expense in birr; x_{4it} represent cost of raw material in birr; β_s are unknown parameter to be estimated. V_{it} follows $N(0, \sigma_v^2)$ and U_{it} follows a truncations at zero of the $N(\mu, \sigma_u^2)$ distribution and guarantees inefficiency to be positive only.

The time-variant technical inefficiency effects are non-negative random variables $\beta_s, \mu, \sigma^2, \sigma_v^2$ and σ_u^2 are parameters to be estimated.

3.3 Description of variables

3.3.1 Dependent and explanatory variable

In this study, the following variables were considered to estimate the inefficiency scores and the inefficiency effects.

1. **Gross Value of output (Y_{it}):** Output of a certain enterprise could be measured either in gross value of output or in terms of value added. Production is the result of the interplay of capital, raw materials, labour, energy and other inputs. Thus, considering gross value of output as measured by net sales to be used as dependent variable is more reasonable.

1. **Fixed capital (X_{1it}):** it represents those assets of the establishments with a productive life of one year or more. It shows the net book-value at the beginning of the reference year plus new capital expenditure minus the value of sold and disposed machineries and equipment and depreciation during the reference period.

2. **Wage and Salaries (X_{2it}):** In the frontier productions, the amount of wages and salaries paid to the workers in each time are proxies for the labour cost. This variable includes all payment made to workers during the reference period (i.e. 2006-2010).

3. **Fuel and energy (X_{3it}):** Fuel and energy used in production process affect the efficiency of brewery industries. In this study, fuel and energy express in terms of monetary value (expense form).

3. **Cost of raw materials (X_{4it}):** this includes all cost of material used in the production process measured in birr.

3.3.2 Identifying sources of technical inefficiency

Knowing that firms are technically inefficient might not be useful unless the sources of the inefficiency are identified (Admassie and Matambalya, et al, 2002). Thus, the second stage of this analysis investigates the sources of the firm-level technical inefficiency for the industries.

Since economic theory does not offer us a clear model to explain the determinants of efficiency, the study does not aim to find causal relations but only correlation between efficiency and a set of variables. Since determining the factor responsible for inefficiency is an essential component of efficiency analysis, the study describes these determinants as follows:

1. Investment Intensity: It is measured by the ratio of net capital additions of the firm during the year to total employment.
2. Export Intensity: this term is measured by the percentage of output exported.
3. Advertisement and Promotion: this variable is measured by the amount of expenses incurred for this purpose.
4. Location: this term is measured by the distance of this industry from the main capital city, A.A.
5. Ownership: it is measured by dummy variables equal to one for government ownership and zero otherwise.

Thus, the model for estimating the determinant of inefficiency is defined as:

$$U_{it} = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + W_{it}$$

Where: α_0 is the intercept term; α_j ($j=1,2,3,\dots,6$) are the parameters for the j^{th} explanatory variable and Z_1 =investment intensity, Z_2 =export intensity, Z_3 =advertisement and promotion, Z_4 =location and Z_5 = ownership.

After, regressing technical inefficiency on the above determinants, we can test the significances of each variables. Furthermore, the result confirms, if there is technical inefficiency or not.

Chapter four

Data analysis

4. Results and Discussion

4.1 Descriptive Results

The study examines the technical efficiency of brewery industry in Ethiopia using secondary data. The data used for analyzing the major variables that affect brewery efficiency are from year 2006 to 2010. Currently, there are five brewery plants in Ethiopia, three of which are government owned and two of them are private owned. The method that employed in our analysis is stochastic production function analysis using panel data.

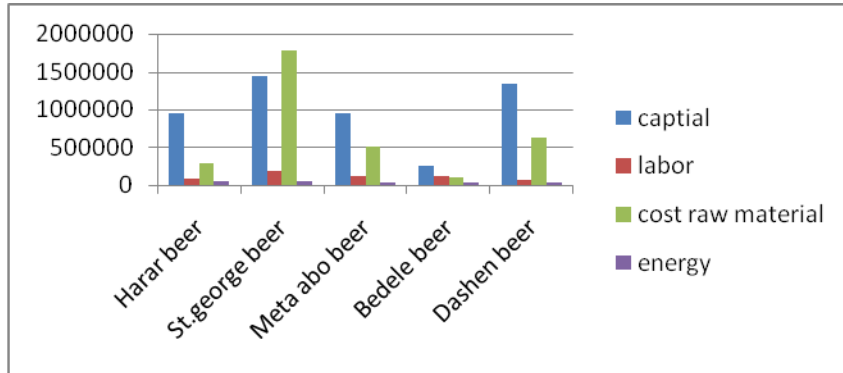
Table 4.1 Descriptive Statistics of breweries during 2006-2010 (in, 000 birr)

Statistics	Output (‘000 birr)	Capital (‘000 birr)	Labour (‘000 birr)	Cost of raw material (‘000 birr)	Energy (‘000 birr)
Average	65041	197229	23170	35518	10833
Max	96568	362975	51984	97268	28397
Min	31936	45016	10623	11082	4384
S.D	17408	94512	10936	26462	5953

Source: own calculation

As indicated in Table 4.1, the 2006-2010 average annual production of the breweries at industry level was 65 million liter. The average input employed for the production includes; fixed capital, labor, energy and cost of raw material which were Birr 197 million, Birr 23 million, Birr 10 million and Birr 35 million, respectively.

Figure 1: Factor of input used in each brewery industry



Source: own calculation.

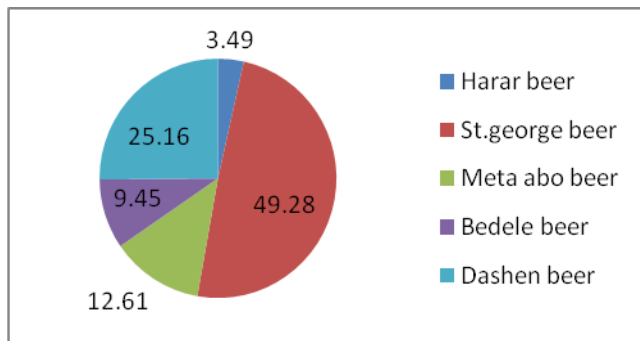
From the figure above, among the five breweries factories, St George employed the maximum amount of inputs whereas the minimum average inputs was used by Bedle brewery factory.

Table 4.2: Market share of the brewery factory

Brewery factories	Market share by sales (%)
Harar beer	3.49
St. George beer	49.28
Meta abo beer	12.61
Bedele beer	9.45
Dashen beer	25.16

Source: own calculation.

Figure 2: Market share (%)



Source: own calculation.

As indicated in table 4.2, St.George beer factory has the highest market share (49.28%), followed by Dashen (25.16%), Meta - abo (12.6%), Bedele (9.45%), and Harar (3.49%).

Table 4.3. Annual Average Major Inputs Productivity of Brewery Industries during 2006-2010
(Values in 000 Birr)

S.N	Variable	2006	2007	2008	2009	2010	Average growth rate (%)
1	Average fixed capital	146232	152249	176880	194267	209918	9.54
2	Average wage	15619	18473	27712	27712	29288	18.49
3	Average Energy and Fuel	11691	11784	8356	8356	11753	3.09
4	Average cost of raw material	68245	95308	177235	177235	188444	32.98

Source : own calculation.

As Shown in table 3, fixed capital grew by 9.54% on average, while wage ,energy and fuel, and the cost of raw materials grew by 18.49%,3.09% and 32.98% respectively.

4.2 Econometrics results and Discussion

4.2.1 Econometric result

The econometrics analysis used a comprehensive panel dataset covering a cross-section of five industries over a period of five year (2006-2010) to estimate the combined frontier- inefficiency model. Stata 10 software programmed was used for the estimation of the different parameters that affect the technical efficiency of brewery industries.

From literature , there are two common functional form of production function employed in studying technical efficiency using stochastic production frontier function namely Cobb-Douglas and general translog functional form.

The first test was conducted to choose the correct functional form which better represents the production function of the brewery industries among the two (Cobb-Douglas and Translog) functional forms. This test is performed using log likelihood ratio test based on maximum likelihood estimation values of the two models.

Table 4.4 Estimation Results for The Cobb-Douglas and translog for the frontier model

Dependent variable :Output							
		Cobb-Douglas			Translog		
Variables	Parameters	Coefficient	S.E	T-ratio	Coefficient	S.E	T-ratio
Constant	β_0	4.543925	2.35856	1.93	231.6729	122.7309	1.89
Capital	β_1	0.3328167	0.210948	-1.32	-22.25391	16.25229	-1.37
Labor	β_2	0.8299127	0.1911672	4.34	-16.98706	14.51649	-1.17
Energy	β_3	-0.3567633	0.0908891	-3.93	-6.302343	5.073978	-1.24
Cost of Raw Material	β_4	-0.004608	0.0936672	-0.05	4.48245	10.24883	0.44
$X_{1it} \times X_{1it}$	β_{11}				0.5275942	0.4033774	1.31
$X_{2it} \times X_{2it}$	β_{22}				0.0579951	0.6035962	0.10
$X_{3it} \times X_{3it}$	β_{33}				0.5632777	0.2350101	2.40
$X_{4it} \times X_{4it}$	β_{44}				0.0750437	0.3897507	0.19
$X_{1it} \times X_{2it}$	β_{12}				2.02008	1.240592	1.63
$X_{1it} \times X_{3it}$	β_{13}				-1.449599	0.9690726	-1.5
$X_{1it} \times X_{4it}$	β_{14}				0.2843686	0.792875	0.36
$X_{2it} \times X_{3it}$	β_{23}				0.8152295	0.3008791	2.71
$X_{2it} \times X_{4it}$	β_{24}				-1.350894	0.8026385	-1.68
$X_{3it} \times X_{4it}$	β_{34}				0.417295	0.463132	0.90
Mu	μ	-0.8651907	6.150845	-0.14	-1.238231	8.743056	-0.14
Sigma square	σ^2	2.040884	5.353984	1.29	2.570486	8.073846	
Gamma	γ	0.9888491	0.0293766	1.96	0.9971569	0.0089624	
Sigma u^2	σ_u^2	2.018126	5.353803		2.563178	8.073806	
Sigma v^2	σ_v^2	0.0227578	0.0072403		0.0073081	0.0023897	
Log likelihood			0.9151475			12.111485	

Source: Stata results

The null hypothesis constrains the existence of all the interaction terms between explanatory variable. It disregards the effect of the interaction between fixed capital and wage, fixed capital and energy, fixed capital and cost of raw material, wage and energy, wage and cost of raw material and energy and cost of raw material. In addition it disregards the effect of the square of each of these four inputs.

The test involves imposing the restriction where $H_0 = \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = \beta_{22} = \beta_{23} = \beta_{24} = \beta_{33} = \beta_{34} = \beta_{44} = 0$. We accept the null hypothesis if $\lambda < \chi^2_{(r)}$ where (r) is the number of restrictions. In our case we have 10 restrictions (all interactions and quadratic terms).

The log likelihood ratio statistics λ is given by;

$$\lambda = -2\{\ln L(H_0) - \ln L(H_1)\}$$

Where $\ln L(H_0)$ is the value of the likelihood functions for the frontier model in which the null hypothesis are imposed (Cobb-Douglas function) and $\ln L(H_1)$ is the value of likelihood functions for the general frontier function (Translog).

If the null hypothesis is accepted we select Cobb-Douglas to be the appropriate functional form and if it is rejected the Translog will be the functional form better representing the production function of the brewery industry.

$$\lambda = -2\{\ln L(H_0) - \ln L(H_1)\}$$

$$\lambda = -2\{0.92 - 12.11\}$$

$$\lambda = 22.4$$

Therefore the likelihood test ratio λ was 22.4. The critical value at 5% significance level using Chi-square distribution with 10 degree of freedom equals 18.31, so the null hypothesis cannot be accepted. Hence we can conclude that the Translog functional form soundly explains the production function of brewery industry relative to Cobb-Douglas functional form.

The second hypothesis test that we performed on the model was to find out whether there is any technical inefficiency in the brewery industry. This is done by imposing the restrictions on the translog model that $\gamma = Z_1 = Z_2 = Z_3 = Z_4 = Z_5 = 0$ where γ is technical inefficiency. The alternative hypothesis is that this is not true.

For the brewery industry with the selected Translog functional form, the computed log-likelihood ratio test statistics λ was $-2[\text{under restricted Translog} - \text{unrestricted Translog}]$ and we compare the results of λ with the critical value. From this result, if λ is greater than the critical value we conclude that the null hypothesis of no technical inefficiency effects on the industry is rejected.

Table 4.5 Restricted and unrestricted model estimation results.

Variables	Parameters	Translog Model (restricted)			Translog Model (unrestricted)		
		Coefficient	S.E	T-ratio	Coefficient	S.E	T-ratio
Constant	β_0	231.6729	122.7309	1.89	99.47518	87.06655	1.44
Capital	β_1	-22.25391	16.25229	-1.37	5.601345	10.89763	0.51
Labour	β_2	-16.98706	14.51649	-1.17	-8.516031	10.0149	-0.85
Energy	β_3	-6.302343	5.073978	-1.24	6.12648	2.947158	2.08
Cost of Raw Material	β_4	4.48245	10.24883	0.44	-21.24916	5.797739	-3.67
$X_{1it} \times X_{1it}$	β_{11}	0.5275942	0.403374	1.31	-0.3740725	0.2397637	-1.56
$X_{2it} \times X_{2it}$	β_{22}	0.0579951	0.603592	0.10	-0.6784356	0.4529741	-1.5
$X_{3it} \times X_{3it}$	β_{33}	0.5632777	0.235011	2.40	0.6577516	0.1361811	4.83
$X_{4it} \times X_{4it}$	β_{44}	0.0750437	0.389757	0.19	-1.072394	0.1897654	-5.65
$X_{1it} \times X_{2it}$	β_{12}	2.02008	1.240592	1.63	1.257974	0.8443407	1.49
$X_{1it} \times X_{3it}$	β_{13}	-1.449599	0.969076	-1.5	-3.379673	0.4521648	-7.47
$X_{1it} \times X_{4it}$	β_{14}	0.2843686	0.792875	0.36	2.083352	0.331154	6.29
$X_{2it} \times X_{3it}$	β_{23}	0.8152295	0.300871	2.71	0.4044468	0.1632986	2.48
$X_{2it} \times X_{4it}$	β_{24}	-1.350894	0.802635	-1.68	0.5058157	0.5264147	0.96
$X_{3it} \times X_{4it}$	β_{34}	0.417295	0.463132	0.90	1.579143	0.2236118	7.06
Advert	AD				-0.0000228	4.25006	-5.37
Distance	D				0.0025761	0.0004457	5.78
Owner	O				0.027326	0.0929413	0.29
Export	E				0.0000587	0.0000123	4.77
Investment I	I				-0.004618	0.0006628	-6.97
Mu	μ	-1.238233	8.743056	-0.14	-26.85966		
Sigma Square	σ^2	2.570486	8.073846		42.41242	20.26827	
Gamma	γ	0.9971569	0.0089624		0.9999774	0.0000131	
Sigma u^2	σ_u^2	2.563178	8.073806		42.41146	20.268277	
Sigma v^2	σ_v^2	0.0073081	0.0023897		0.0009583	0.0003048	
Log likelihood f	Lf			12.11485			30.150113

Source: Own estimation results.

The log likelihood ratio statistics λ is given by:

$$\lambda = -2 \{ \text{restricted} - \text{unrestricted} \}$$

$$\lambda = -2 \{ 12.11 - 30.15 \}$$

$$\lambda = 36.08$$

The likelihood ratio test statistics λ is 36.08. The critical value at 1% significance level using Chi-square distribution with 5 degree of freedom is equal to 15.09. Therefore we strongly reject

the null hypotheses. Hence, the result indicates that there is technical inefficiency effect in the brewery industry.

The third null hypothesis $H_0: \eta=0$, specifies that the technical inefficiency effect does not vary significantly over time where as if the null hypothesis is rejected indicating that the technical inefficiency effect varies significantly over time (i.e. time varying). If the value (η) is positive the inefficiency effects decreases over time in the industries and vice-versa.

Table 4.6 Comparison of translog time invariant with time varying inefficiency effect.

Variables	Parameters	Translog Model (Time Invariant)			Translog Model (Time Variant)		
		Coefficient	S.E	T-ratio	Coefficient	S.E	T-ratio
Constant	β_0	99.47518	87.06655	1.44	4.193611		
Capital	β_1	5.601343	10.89763	0.51	229.0698	31.8887	7.34
Labour	β_2	-8.516031	10.0149	-0.85	-14.26294	8.301715	-1.72
Energy	β_3	6.12648	2.947158	2.08	-64.46973	3.871793	-16.65
Cost of Raw Material	β_4	-21.24916	5.797739	-3.67	-180.04113	27.33673	-6.59
$X_{1it} \times X_{1it}$	β_{11}	-0.374072	0.239767	-1.56	-9.351625	1.249623	-7.48
$X_{2it} \times X_{2it}$	β_{22}	-0.678435	0.452974	-1.5	1.584814	0.4827666	3.28
$X_{3it} \times X_{3it}$	β_{33}	0.6577516	0.136181	4.83	3.829423	0.9890005	3.87
$X_{4it} \times X_{4it}$	β_{44}	-1.072394	0.189765	-5.65	-9.063751	1.379619	-6.57
$X_{1it} \times X_{2it}$	β_{12}	1.257974	0.844341	1.49	-20.07338	1.47691	-13.59
$X_{1it} \times X_{3it}$	β_{13}	-3.379673	0.452165	-7.47	-8.232689	3.880216	-2.12
$X_{1it} \times X_{4it}$	β_{14}	2.083352	0.331154	6.29	24.48001	4.039647	6.06
$X_{2it} \times X_{3it}$	β_{23}	0.4044468	0.163299	2.48	11.31119	2.137359	5.29
$X_{2it} \times X_{4it}$	β_{24}	0.5058157	0.526415	0.96	10.18168	0.673656	15.11
$X_{3it} \times X_{4it}$	β_{34}	1.579143	0.223611	7.06	-1.417979	0.7821088	-1.81
Advert	AD	-0.000023	4.25006	-5.37	0.0000317	1.71	0.086
Distance	D	0.0025761	0.000445	5.78	0.0003675	0.0006985	0.53
Owner	O	0.027326	0.092941	0.29	-0.751472	0.3579694	-2.10
Export	E	0.0000587	0.000012	4.77	-0.000671	0.0000266	-25.25
Investment I	I	-0.004618	0.000662	-6.97	-0.0115824	0.0016003	-7.24
Mu	μ	-26.85966			0.117548	1.838829	0.06
Sigma Square	σ^2	42.41242	20.26827		0.0793271		
Gamma	γ	0.9999774	0.0000131		0.8624653		
Sigma u^2	σ_u^2	42.41146	20.26827		0.0684169		
Sigma v^2	σ_v^2	0.0009583	0.0003048		0.0109102		
Eta	H				-1.898136		
Log likelihood f	Lf			30.15011			4019.06

Source: Own estimation results.

The log likelihood ratio statistics λ is given by:

$$\lambda = -2 \{ \text{time invariant} - \text{time variant} \}$$

$$\lambda = -2 \{ 30.15 - (-4019.06) \}$$

$$\lambda = 8098.42$$

The likelihood test ratio λ is 8098.42. The critical value at 1% significance level using Chi-square distribution with 19 degrees of freedom is equal to 36.19. Therefore, we strongly reject the null

hypotheses. Since the hypothesis is rejected, we conclude that there were time varying technical inefficiency effects in the brewery industry. Meanwhile, the value (η) is negative implying that the inefficiencies effect increases over time in the industry.

4.2.2 Discussion

4.2.2.1 Interpretation of the production function estimation results.

All explanatory variables and the dependent variable have been transformed in to logarithm before estimation.

The coefficient on capital has a positive sign and significant at 1 % level of significance. A one percent increase in fixed capital expenditure leads to 229% increase in sales. This indicates that capital (installed capacity) were the vital causal variable to explain production efficiency of the brewery industry. This is due to the fact that during the considered period most of the brewery factories replace the old ,worn-out and obsolete machineries and equipments with the new ones, since these new machineries and equipments are the major component of fixed capital ,this contributes soundly to enhance the technical efficiency of the industries.

The coefficient on labor has a negative sign and is found to be insignificant in the production functions. The negative relationship between labor and technical efficiency can be explained by the fact that three out of the five factories are owned by the government. The history of the factories revealed that two out of the three factories were established by the previous government based on labor intensive strategy, thus this factories incur high wage expenses with low efficiency. Besides this labor policy has not yet been changed and hence the factories excessive labor that negatively contribute to the efficiency of the industries. This negative impact of labor on the efficiency could be due to a large amount of disguised labor that is employed on relatively small amount of capital.

The coefficient on energy has a negative sign and is statistically insignificant .This shows that energy and fuel inputs are not important to explain production efficiency. It implies that in the period considered, electric power interruption and foreign currency rationing was common phenomena in Ethiopia. Therefore energy and fuel inputs may not be sufficiently available for the production of beer in the industries. Thus energy and fuel do not properly indicate the efficiency of the brewery industry even though the variable was important in most literature.

The coefficient on cost of raw materials has a negative sign but statistically significant at 1% significance level, A one percent increase in cost raw material expenditure lead to 180% decline in sales. This indicate that the cost of raw material negatively affect the efficiency of the brewery industry due to the fact that, Malt barely ¹ is the major raw material which account for about 90% of the total raw material cost for beer production. Hence, 80% of this raw material in the considered period was imported from abroad. Moreover, the current government devaluated the currency since 2008 for five times, making import of malt very expensive that the share expenditure for this raw material would be high. These led the brewery factories to reducing the budget set for expansion of other activities which may increase the efficiency. Since the country has suitable agro-ecological conditions and comparative advantage in the production of malt barley, an investment to substitute this raw material domestically may enhance the efficiency of the industries further.

On the other hand, when we see the interaction between variables, there exists of a positive association between labor square and energy square with technical efficiency and a negative association between labour and energy with technical efficiency at individual level. These behaviors can be explained by the fact that there exist inverted U-shape relationships. This is relationship can be interpreted to mean that technical efficiency increase until a firm labour and energy inputs threshold is reached and decreases with an increase in labour and energy inputs.

The second order parameter of capital, cost of raw material, energy , labor and their interaction are significantly different from zero .This indicates that the rejection of the Cobb-Douglas model as an adequate representation of the brewery industry is justified because the function is non-linear to some extent and there exist important interaction among the variables. Besides these unexpected signs and the insignificance of the coefficients can be attributed to the nature of translog functional form which causes multicollinearity problems arising from the inclusion of squared or quadratic terms and cross -products of the input variables. However, since the purpose of the study is to predict efficiency, multicollinearity will not be a serious problem and some degrees of multicollinearity can be tolerated (maddala, 1992).

Lastly, the paper examines the results of different determinant that affect the technical efficiency of brewery industry as follows:

¹ Malt barely is a malting crop used to produce malt for brewery.

Advertisement Expenditure: which is measured by the expense incurred for the purpose, the sign on the coefficient of advertisement is positive but statistically insignificant in explaining inefficiency. This implies that most of the brewery factories promote their product through different media and price incentives. Therefore advertisement has not led to an increase in market share.

Distance: The sign of the coefficient of distance is positive and statistically insignificant, this indicates that no difference in technical efficiency score prevail between factories in the main city and other towns, this finding is inconsistent with new economic geographic theory suggests that industry will benefit if they can produce in nearby location to the city. This may be because most of the brewery factories focus on the people that live around the areas where the plants are built.

Owner: The sign of the coefficient of ownership dummy is negative and statistically insignificant. This can be explained by the fact that there is no technical inefficiency difference between the government and private owned brewery factories.

Export: The sign of the coefficient of the variable export is negative but statistically significance at 1% significance level. This indicates that technical inefficiency decline in the future with an increase in export amount. The results indicate that getting market access abroad makes the brewery industry to improve efficiency.

Investment Intensity: This is measured by the ratio of net capital addition of the firm during the year to total employments. The study found that the sign of the coefficient of investment intensity is negative but statistically significant at 1% significance level. The result indicates that the variable plays an important role in explaining technical inefficiency in the industry. In other words technical inefficiency declines with an increase in investment intensity.

4.2.2.2 Interpretation of the variance parameter

The ratio of plant –specific variability to total variability which is given by Y is 0.86. This means that 86% of the observed output variability is mainly due to firm specific performance where as 14% variability is due to random shocks. The finding shed light on the possible source of this shock which is mainly explained by two factors that are infrastructural and institutional.

On the infrastructure side; power supply is poorly available to the factories, power rationing and interruption are common features in Ethiopia for the considered period, even though, huge

potential of hydroelectric power exists in the country. Moreover poor road network and communication facilities were also the challenges for the industry.

On Institutional side; institution in Ethiopia are characterized by poor service provision, especially in the municipality and customs authority such as acquisition of land and clearing import which are a difficult tasks, the other severe problems were shortage of foreign currency and availability of alcohol. Finally, this random shock which is beyond the control of the factories weighs in for the technical inefficiency of the industry.

4.3 Mean technical efficiency of Brewery plants

The mean technical efficiency of brewery industries during 2006 to 2010 were calculated by using frontier software developed by Tim Coelli (version 4.1)

Table 4.7: Mean technical efficiency of five brewery plants

S.N	Name of brewery	2006	2007	2008	2009	2010	Average
1	Harar beer	0.966	0.888	0.827	0.960	0.808	0.889
2	St.George beer	0.894	0.967	0.722	0.857	0.820	0.852
3	Meta beer	0.476	0.466	0.696	0.796	0.532	0.593
4	Bedele beer	0.976	0.945	0.948	0.934	0.824	0.829
5	Dashen beer	0.701	0.787	0.835	0.870	0.611	0.761
	Average	0.803	0.811	0.806	0.883	0.719	0.804
	Min	0.476	0.466	0.696	0.796	0.532	0.593
	Max	0.976	0.967	0.948	0.960	0.824	0.899

Source Own estimation results

The study identified that the mean efficiency of brewery varies among the plants and year –wise mean seems to be unstable during the study period.

The mean efficiency of the brewery plants for the considered period is 80%, which means there is 20% inefficiency in production. On average the brewery industry produces 80% the maximum attainable output level over the period, this indicates that given existing resources and technology, output could be increased by 20% by tackling production inefficiency .In other word, on average technical inefficiency caused actual production to fall below maximum potential production by slightly less than 20%.

The average efficiency steadily decreases from 80.3% in 2006 to 71.9% in 2010. The minimum efficiency score registered by Meta-Abo in 2007 is 0.466 (47%) where as the maximum registered by St. George in 2007 is 0.967(97%).

Chapter five

Conclusions and recommendations

5.1 Conclusions

The study examines technical efficiency of the five brewery plants in Ethiopia. The analysis was based on panel data of the five brewery plants for the period 2006-2010. It formulates a hypothesis that for the considered period all brewery plants in Ethiopia are technically efficient. This hypothesis was based on stochastic production frontier which was estimated using a two-stage estimation method using Frontier version 4.1.

The main findings of the study revealed that:

- A log-likelihood ratio test estimated by maximum likelihood estimation showed that the production process of the brewery industry was better specified as Translog production function.
- There is a technical inefficiency effect in the brewery plants of Ethiopia.
- The technical inefficiency effect of the brewery industry was varying significantly over time.
- The coefficients on capital were positive where as that of cost of raw material were negative but both were statistically significant.
- The coefficient of labour, energy and fuel were statistically insignificant.
- Out of the five factors included to explain technical inefficiency only two factors (export and investment intensity) have a significant effect on technical inefficiency.
- The coefficient on ownership dummy was statistically insignificant. This can be explained by the fact that there is no any technical efficiency difference between the government and private brewery plants.
- The gamma value (γ) showed that 86% of the inefficiency is due to firm specific technical inefficiency effect where as 14% is due to statistical noise which is beyond the control of the plants.

Moreover, there are other findings related to mean efficiency indicated as follows:

- ❖ There is identifiable mean technical efficiency difference among the plants, the lowest mean efficiency is registered by Meta –Abo which is 0.593 where as the maximum score is registered by Harar which is 0.889.

❖ The mean technical efficiency for the brewery industry was 80%, which means on average there were 20% inefficiency in production. Besides it fluctuated over the considered period. Finally, the firm specific inefficiency listed above arises mainly from lack of skilled labor and poor managerial skills, shortage of raw material and unavailability of foreign currency. In addition, external factors such as infrastructure and institutional factors are the factors that contribute to inefficiency.

5.2 Recommendations

Based on the study results we suggest the following recommendations that are relevant for improving the inefficiency of brewery industry.

Firstly, managers and employees are characterized by lower educational status; R&D and industrial level training were limited. To address these problems it's necessary to reorient the education system to practical based. Plants should also adopt plant level training and a flexible management system to avoid labor turnovers. The Government should also encouraged R&D by linking the brewery industry with research organization and universities.

Secondly, regarding cost of raw material, malt is the major input (about 90% of the total raw material cost) for beer production. Despite having a suitable agro-ecological conditions and comparative advantage in production of malt barley, the brewery industry in general needs to identify the major constraints hindering the sector and take the necessary steps to improve production accordingly there should be ways of producing this input domestically.

Thirdly, the study found that 14% of the inefficiency arises due to statistical noise which is beyond the control of the industry; the source of this inefficiency is better explained by two factors institutional and infrastructural factors.

On the institutional side, the industry is challenged by large number of delays at different government institution such as land acquisition which is time taking on average it takes more than four months to acquire land for expansion purpose ,the lease cost for land and its upfront payment are also large. Meanwhile, clearing of imports are time taking and challenging since the industry activities rely on imported inputs and raw materials. Hence the longer the time to clear imports, then the larger will be the effect on the industry performance. This again induce a big entry barrier to new entrants .Therefore the government should give due attention to lessens this problem.

Regarding the infrastructural problems, power outage is the major constraint to the industry. Production activities require lots of processing and this need huge and continuous power supply. Besides this plant which uses high capacity generators to deal with power rationing and frequent interruptions are few. Thus, power supply has to be ensured through proper management of existing dams and speed up the completion of the dams under construction by the government. Transport and communication facilities were also other infrastructural problems in the industry. There is a need to improve the road networks especially in the processing zones and ports. Fourth, recently the government sold two of the state owned brewery plants Harar and Bedele to Heineken which is a foreign beer company. This will create oligopoly market structure and increase concentration of the plants. It's obvious that industries that operate in markets with few rivals have a more market power than industries in markets with many competitors. This is against the principle of competition policy and detrimental to consumer interest. Therefore, the government should reconsider its policy of privatization.

In general, the overall results indicate that there exist a potential to increase the technical efficiency of the brewery industry through improving and utilizing the existing resources as well as tackling internal and external problems that hinder the development of the industry.

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