ADDIS ABABA UNIVERSITY

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Analysis of Technical Efficiency of the Ethiopian Agro-Processing Industry: The Case of Biscuit and Pasta Processing Firms

BY

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Dr. Tekie Alemu	----------------	----------------

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Abstract

This study aims at determining the level of technical efficiency of the Ethiopian private and public pasta and biscuit industries over time 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 study considered 15 private and 5 public pasta and biscuit industries for the period of 2004/05-2008/09. The translog functional form with maximum likelihood estimation better explains the production behaviour of private as well as public pasta and biscuit industries. It shows that there is technical efficiency difference among industries in the sector. The mean technical efficiency of public pasta and biscuit industries was 0.12 while that of private industries was also 0.11, showing an increasing trend in both industries. Poor quality of wheat, poor linkage between private industries and state farms and poor technology are the main constraint of the sector. Public industries, slightly speaking, have better efficiency and scale of operation as compared to private industries mainly attributed to the linkage between public wheat firms with public pasta and biscuit industries. External constraints including lack of modern marketing skill, financial resources and lack of sufficient professional food technologist contribute more to the low level of development of the sector. In order to effectively utilize agricultural resource and benefit from this sector, efforts have to be made in improving linkage between state farms with privet companies, working to scale up the production of best quality of wheat(Durum wheat), infrastructure development, technical and skill development and availability of updated marketing information system. The creation of conducive business environment enhances the development of the sector.

Keywords: Agro- processing sector, stochastic production function and technical efficiency.

1. INTRODUCTION

The economy of Ethiopia is based on agriculture, which accounts 43.2% of gross domestic product (GDP), 60% of exports, and 80% of total employment (The Ethiopia macroeconomic Hand book, 2010). While the industrial sector accounts for 13.2% of the GDP, 9.5% of total employment and 21.2% of export earnings (CSA, 2007/08). The manufacturing sector accounts for 43% of the industrial sector. Within the manufacturing sector, the food processing subsector is the largest subsector, accounting for 20% of the total gross value of production (GVP) and 34% of the value added at market price (VAMP) of large and medium scale manufacturing industry, which itself contributes 69% of GVP of manufacturing sector (CSA, 2007/08).

Under Ethiopian context the food industries include cereal processing industries (pasta, macaroni, biscuit, bread and flour industries), oil seed processing group, sugar processing, coffee and tea processor, honey and wax processor and breweries. Of these, pasta (macaroni) and biscuit accounts for 2.7% and 14.8% of food industry employment in 2008, respectively (MoTI, 2008).

Wheat is considered to have a wide base for pasta (macaroni) and biscuit industry development. This subsector is labor-intensive, has simple and easily attainable technology and proximity to COMESA, Middle East and European market plus government policies have focused on improving the business environment, which has had a positive impact on the facilitation of food industry investments and improved economic performance.

According to UNIDO’s (2009) strategic plan of the sector, food industries development in Ethiopia is still very much in its infancy; their products have difficulties in complying with international standards and the trade balance for processed food products remains substantially negative, which is an indication of very high, unexploited domestic market potential for food industry development.

Major factors contributed for low development of the sector are low effort to improve process technology, marketing management and conforming to standards, low labor productivity, intense competition in the world market, small size and type of ownership.

According to, UNIDO Strategic Plan for the Ethiopian Agro-processing Industry Products 2009, Ethiopia is the origin for durum wheat in the world .Some parts of the country like Arsi-Bale region is well known for the production of high quality wheat. The country, however, generates less export earnings from the production and export of pasta and macaroni from durum wheat. In 2006/07 the number of bakery products establishments was 127, of which five were state enterprises and 26 were medium and large scale biscuit and macaroni (pasta) processing enterprises and five of them are state owned (MoTI, 2009).

Ethiopian manufacturing is particularly dominated by food production. In 2006/07 biscuit, pasta and macaroni accounted for 7.7% of the manufacturing value added and 9% of employment (CSA, 2008). Agricultural resources that are the base for biscuit, pasta and macaroni manufacturing are available in fairly large quantities, being the main source of comparative advantages of the sector. However, actual utilization of the sector largely depends on the ability to operate efficiently and the ways industries are managed. It is generally believed that resources in the manufacturing industries, especially in underdeveloped countries, are being utilized inefficiently.

In general the concept of efficiency in production has long interested economists since Adam Smith. It is in recent years that an increasing interest on the part of economists in measuring technical efficiency have emerged (Farrell, 1957; Richmond, 1974).

Farrell's (1957) seminal article has lead to the development of several techniques for the measurement of efficiency of production. These techniques can be broadly categorized into two approaches: parametric and non-parametric approaches with their own weaknesses and strengths.

On the efficiency differences between private and public sector enterprises, there appears to be greater uniformity in the findings of different literature. A number of studies have found that public sector enterprises are relatively less efficient than their counterparts in the private sector (e.g. Bitros, 2003; Chirwa, 2001; Onder et al., 2003). However, the important question is, "what makes public sector enterprises less efficient?" Opinions differ on this question. For example, Bartel and Harrison (1999) examined the causes of inefficiency of public sector manufacturing enterprises in Indonesia and found that the inefficiency of public sector enterprises was not due to public ownership *per se*, but was attributable to the fact that they operate under a soft budget constraint. They also found that the inefficiency was relatively greater in those public sector enterprises, which were shielded from import competition.

In Ethiopia Efficiency studies are not conducted sufficiently on manufacturing sector of the country. Despite the fact that technical efficiency of small holder farmers has been extensively studied in Ethiopia, there are limited efficiency studies on technical efficiency of the country's industries.

Daniel (2005) conducted a study to measure technical efficiency among the Ethiopian manufacturing industries and analysed factors that were attributable to the existing level of technical inefficiencies.

Genet (2009) estimated industry- level technical efficiency of tanneries and leather footwear industries and analyzed the change in technical efficiency of these industries during the periods 2003-2007. In addition, comparative analysis between more value-adding and less value-adding tanneries as well as between exporting and non-exporting leather footwear industries was performed.Even if these studies were conducted, there is no a specific research on the Ethiopian food industrial sector, especially on pasta and biscuit producing firms.

With this backdrop, the main objective of this study was to estimate industrial level technical efficiency of medium and large scale biscuit and pasta industries and to analyse the change in technical efficiency of these industries over the last consecutive five years. The study also aimed at comparing technical efficiencies of private and public biscuit and pasta industries.

In addition, comparison of private and public biscuit and pasta processing industries' technical efficiencies was made, assessed the change in technical efficiency over the past five years among public and private industries, factors affecting efficiency/inefficiency of the industries under the study was identified.

The study would help researchers and policymakers to understand the technical efficiency trends of industries and factors affecting their inefficiencies. Relying on the existing input and production technology, it would enable to find remedies for industrial inefficiencies as well as policy measures with the proper utilization of the scarce resource of the country.

This research tried to estimate efficiency of pasta & biscuit industries based on parameter of total cost as a function of gross value of output, wage rate, industrial cost and fixed capital. But estimation of inefficiency effects requires additional managerial variables which are beyond the scope of this study as this research utilized secondary data for analysis. Plus comparison between private and public industries was made with unequal number of firms which might affect the output of the model.

The rest of the paper is outlined as follows. The next section deals with review of related literature. In the third section data source and methodology are described. The fourth section discusses the descriptive and econometric results and conclusions and policy implications are provided in the last section.

2. REVIEW OF RELATED LITERATURE

Technical efficiency is a measure of how well the individual industry transforms inputs into a set of outputs based on a given set of technology and economic factors (Aigner, Lovell, and Schmidt, 1977; Kumbhakar and Lovell, 2000). Two firms using the same set of inputs and technology may produce considerably different levels of output. While part of the difference may just be random variations found in all aspects of life, other parts may be attributed to individual firm fundamental attributes and to opportunities that could be influenced through public policies. One attribute may be influenced by public policies while another is not. Yet, in both settings, the impact of these attributes on the level of output can sometimes be measured.

Technical efficiency is just one component of overall economic efficiency. However, in order to be economically efficient, a firm must first be technically efficient. Profit maximization requires a firm to produce the maximum output given the level of inputs employed (i.e. be technically efficient), use the right mix of inputs in light of the relative price of each input (i.e. be input allocative efficient) and produce the right mix of outputs given the set of prices (i.e. be output allocative efficient) (Kumbhaker and Lovell 2000).

These concepts can be illustrated graphically using a simple example of a two input (x_1, x_2)-two output (y_1, y_2) production process (see Figure 1 below). Efficiency can be considered in terms of the optimal combination of inputs to achieve a given level of output (an input-orientation), or the optimal output that could be produced given a set of inputs (an output-orientation).

In Figure 1(a) below, the firm is producing a given level of output (y_1^*, y_2^*) using an input combination defined by point "**A**". The same level of output could have been produced by radially contracting the use of both inputs back to point B, which lies on the isoquant associated with the minimum level of inputs required to produce (y_1^*, y_2^*) (i.e. Iso(y_1^*, y_2^*)). The input-oriented level of technical efficiency ($TE_I(y,x)$) is defined by 0B/0A.

However, the least-cost combination of inputs that produces (y_1^*, y_2^*) is given by point C (i.e. the point where the marginal rate of technical substitution is equal to the input price ratio w_2/w_1). To achieve the same level of cost (i.e. expenditure on inputs), the inputs would need to be further contracted to point D. The cost efficiency (CE(y,x,w)) is therefore defined by 0D/0A.

The input allocative efficiency (AE_I(y,w,w)) is subsequently given by CE(y,x,w)/TE_I(y,x), or 0D/0B in Figure 1.1(a) (Kumbhaker and Lovell 2000).

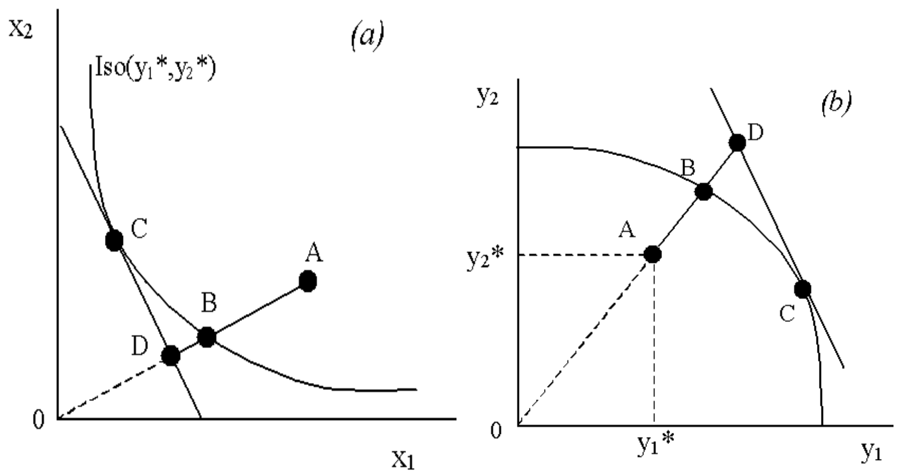

Figure 1: Input (a) and output (b) oriented efficiency measures

Source: Kumbhaker and Lovell 2000

The production possibility frontier for a given set of inputs is illustrated in Figure 1(b) (i.e. an output-orientation). If the inputs employed by the firm were used efficiently, the output of the firm, producing at point A, can be expanded radially to point B. Hence, the output oriented measure of technical efficiency (TE_O(y,x)), can be given by 0A/0B.

This is only equivalent to the input-oriented measure of technical efficiency under conditions of constant returns to scale. While point B is technically efficient, in the sense that it lies on the production possibility frontier, higher revenue could be achieved by producing at point C (the point where the marginal rate of transformation is equal to the price ratio p_2/p_1). In this case, more of y_1 should be produced and less of y_2 in order to maximize revenue.

To achieve the same level of revenue as at point C while maintaining the same input and output combination, output of the firm would need to be expanded to point D. Hence, the revenue efficiency (RE(y,x,p)) is given by 0A/0D.Output allocative efficiency (AE_O(y,w,w)) is given by RE(y,x,w)/TE_I(y,x), or 0B/0D in Figure 1(b) (Kumbhaker and Lovell 2000).

Using standard statistical tools, factors contributing to different levels of technical efficiency can be measured. Such factors range from firm size to producer demographic characteristics. Some of these have the potential of being directly influenced through public policies in the short run while others, such as education, may take years to bring about change.

There is a large literature available on assessing technical efficiency of firms (e.g., Green and Mayes, 1991). But, likely because of the lack of appropriate variables most studies solely focus at estimating frontier functions and at obtaining technical efficiency estimates, but do not go further and analyze the determinants of technical efficiency/ inefficiency.

However literatures which access determinant of efficiency hypothesis the following as factors that affect technical efficiency/ inefficiency of industries:

Size: In the literature the relationship between firm size and performance received thorough attention. On the one hand, larger firms have better penetration in the market and they can exploit economies of scale; moreover, larger firms have more funds to employ better manager (Kumar, 2003); studies which focus explicitly on the relationship between firm size and technical efficiency (e.g. Alvarez and Crespi, 2003, Caves and Barton, 1990, Gumbau-Albert and Maudos, 2002, Meeusen and van Den Broeck, 1977, Torii, 1992) found that the technical efficiency increases with firm size of the firm. On the other hand, in the larger firm it is more difficult to keep all departments coordinated, i.e. efficient.

That is why one may speak about optimal firm size (Maksimovic and Phillips, 2002) and, consequently, non-linear relationship between size and firm performance.

Out sourcing**:** Outsourcing activities decomposed into three different types, external contract work and services, material inputs and operating leasing were found to have positive and significant influence on firm performance measured as return on sales (Görzig and Stephan, 2002).

Research and Development (R&D)**:** In the literature, the results for the relationship between technical efficiency and R&D investments are ambiguous. R&D may increase innovative activity on the one hand, but may also alter the strategic interaction between firms e.g. market shares (Bartelsman and Doms, 2000). Albach (1980) and Caves and Barton (1990) find a negative impact of R&D intensity on technical efficiency. In explaining this negative effect Caves and Barton (1990, 76) suppose that R&D expenditures made in a certain industry are only a poor predictor of the innovativeness of that industry because large parts of the innovation output is applied in other industries. Fritsch and Stephan (2004) also find a negative relationship of R&D and technical efficiency at the industry level.

Industry effects: In this respect Oleg Badunenko, Michael Fritsch and Andreas Stephan work "what determines technical efficiency of firms?" is pioneering, since most of the literature devoted to industry effects and firm performance focuses on accounting measures (or their derivatives) of firm's performance, namely profitability measures. Schmalensee (1985) looked at the variation of accounting rates of return and found that these are mostly explained by industry effects, while market share effects were negligible, and firm effects had zero explanatory power. Among the numerous follow up papers, Wernerfelt and Montgomery (1988) used Tobin's *q* as a measure of firm performance.

The main difference with Schmalensee's research is that firm effects do exist in a form of focus effects, namely the difference in performance can be explained by efficiency differences, which firms experience in transferring competencies to widely varying markets. These controversial outcomes triggered deeper research in the field of Strategic Management; Brenner et al. (2001) provide thorough survey of later studies, which focused on estimating the role of firm, industry and other effects in firm performance.

Stochastic frontier approach has found wide acceptance within the economics literature and industrial settings (Battese and Coelli, 1992; Coelli and Battese, 1996), because of their consistency with theory, versatility and relative ease of estimation.

A number of studies examined the technical efficiency of manufacturing industries in developing countries (Nishimizu and Page, 1982; Abdulkhadiri and Pickles, 1990; and Chuang, 1996, Harris 1993, Sheehan 1997) and steel production (Wu, 1996).

In the literature this method is classified into two groups based on the approach chosen to estimate the production function of the fully efficient firm. The two approaches are non-parametric and parametric (Coelli et 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 does not impose any functional form on the data, whereas its main disadvantage is its assumption of constant returns 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 into deterministic and stochastic.

According to Cororaton et al. (1995), technical efficiency can be measured using deterministic or stochastic method. The deterministic method lump sums the source of deviation of the observed output from the frontier production level due to inefficiency and other exogenous factors and considers the combination as inefficiency. Moreover, the deterministic model assumes that the production frontier is common to all firms with given level of inputs and that inter-firm variation is, therefore, attributable only to difference in efficiency (Coelli et al., 1998).

In order to overcome these problems the stochastic frontier production function, developed by Farrell (1957), has been developed by Aigner, Lovell and Schmidt (1977) and Battese and Coelli (1995). This stochastic frontier production approach involves an observable random variable associated with the technical inefficiency of production of individual firms in addition to the random error in deterministic frontier.

The stochastic frontier production function is often recommendable because it is the only one that allows the deviation of an observation from the frontier due to both technical inefficiency and random noise.

Panel data based econometric models can generate consistent estimates that account for unobservable heterogeneity among firms. Panel data in efficiency analysis gives an opportunity to examine and model behaviour of technical efficiency over time (Coelli et al., 1998). Moreover, we can measure technical inefficiency effects' change over a period of time using stochastic frontier production time varying model for panel data.

In empirical literature the stochastic frontier application is predominant. The stochastic frontier production function can be specified as Cobb-Douglas, Constant Elasticity of Substitution, Trans log etc. functional forms. Different authors used likelihood ratio test to select among different functional forms.

Empirical production analysis tests if the observed behaviour is consistent with the effective utilization of input resources subject to the production technology and quantifies deviations from optimization, which is inefficiency.

Most empirical studies concentrate on technical inefficiency since technical inefficiency appears to be an important source of under-performance. It also embodies all the managerial and organizational sources of inefficiency.

There is a dearth of empirical work in Ethiopia on technical efficiency of farming systems across agro-ecological zones. Most of the studies conducted so far focused on land renting and sharecropping issues (see Gavian and Ehui, 1999; Ahmed *et al*, 1998; Tesfay *et al*, 2005; Tesfay, 2006, and Kassie and Holden, 2007).

Despite the fact that technical efficiency of small holder farmers has been extensively studied in Ethiopia, there are limited efficiency studies on technical efficiency of the country's industries. Daniel (2005) conducted a study to measure technical efficiency among the Ethiopian manufacturing industries and analysed factors that were attributable to the existing level of technical inefficiencies. He utilized the model developed by Battese and Coelli (1995) to estimate technical efficiency and considered panel data of 361 firms categorized in nine industrial groups for the period 1998-2002. His empirical findings suggest that there is a technical inefficiency among firms in the entire industrial group in the considered period. In this study, the food sector is one of the industrial groups which showed significant inefficiency differential among the firms. Moreover, he found that firm size had positive effect in increasing the efficiency of the sector.

Genet (2009) has focused on the measurement technical efficiencies of tanneries and leather footwear industries in the country over the period of 2003-2007. She compared technical efficiency levels of more value-adding tanneries with less value-adding tanneries as well as those of exporting leather footwear industries with non exporting leather footwear industries.

She used stochastic frontier model, developed by Battese and Coelli (1995), to estimate the production of these industries based on panel data of 11 tanneries and 28 leather footwear industries for the year 2003-2007. A log-likelihood ratio test showed that production processes of tanneries and leather footwear industries were better specified as a translog production function and estimated with maximum likelihood estimation.

The result shows that the average technical efficiency for tanneries was 0.77 and there was an increasing trend over the considered period. Tanneries utilized 78% of their production capacity. There was large disparity among industries in production and in production capacity utilization. While the leather footwear industries had an average efficiency of 0.84, implying less potential for efficiency improvement as compared to tanneries. Like the tanneries, the leather footwear industries' efficiencies had increased over the period 2003-2007.

Yifru 2007, in his project work explained the characteristics of selected pasta, macaroni and biscuits producing firms in terms of the industrial organization model of structure-conduct-performance. The finding reveals that the market is highly concentrated.

The concentration of pasta and macaroni producing firms as measured by CR3 of i.e. three of the firms producing pasta and macaroni - Dire Dawa Food Complex, Kaliti Foods SC, and Kokeb Flour and Pasta Factory have been dominating the market from 2002/03 to 2005/06 with a concentration ratio of 76% to 46% respectively. As the concentration ratio dropped from 76% to 46% due to new entrants so did the performances to a certain extent. The combined performances of these three firms as measured in terms of their operating profits and return on investment dropped from 7.75% to 0.19% and from 7.10% to 0.14% respectively in the period under review.

The return on invest was lower than the bank interest rate which proves the poor performances of these firms. Market entry in terms of capital requirement and access to quality wheat supply in the pasta and macaroni business is higher than that of biscuits investment. That is why the number of existing firms operating in the biscuits market is fourteen, while that of pasta and macaroni markets are eight.

Like that of the pasta and macaroni producing firms, the biscuits market is characterized by high degree of concentration. The concentration ratio (CR4) of the four firms that was 53% in 2002/03 grew to 91% in 2005/06. Two of the firms namely NAS Foods and 2Brother had 85% of the market share. NAS Foods alone had 55% of the market in 2005/06, followed by 30% of 2Brothers.

Although the biscuits market is somehow concentrated, the market leader or dominant firm does not charge higher prices at the retail level as that of Pasta and Macaroni sub-sector. At the wholesalers level however, firms charge different prices with a range of Birr 2 to Birr 4 per carton. The overall average capacity utilization of the five firms covered in this study was 65% in 2006. Their capacity utilization in 2006 declined mainly because of expansions made by Dire

Dawa Food Complex on its pasta and macaroni lines from 7272 tons and 7272 tons to 16059 tons and 18786 tons per year respectively, and that of 2Brother's additional biscuits line with a capacity of 6000 tons per year.

However the capacity utilization of individual firms varies significantly. Dire Dawa Food Complex that contributes 67% (34845 tons) of the production capacity of the three firms has contributed 68% (22956 Tons) of the total products produced in 2005/06. In terms of capacity utilization by product, pasta had higher utilization rate (69%) than the rest of products. Dire Dawa Food Complex, the market leader in the sector, had 70% capability utilization for pasta (Spaghetti) product, followed by Kaliti Food SC at 69%. Kokeb and Kaliti Foods had relatively better capacity utilization in 2006 although their combined capacity was much lower than that of Dire Dawa Food Complex. The average capacity utilization rate of the four biscuits producing firms in 2006 was the lowest in the sector i.e. only 47%.

This below average performances was attributed to the poor performances of the two firms, namely Dire Dawa Food Complex (34%) and Kaliti Food Complex (3%). NAS Foods which leads the biscuits industry had a capacity utilization of 97% followed by 2Brother, a challenger in the industry, by 67%.

3. RESEARCH METHODOLOGY

3.1 Data

The study based on panel data set of 20 firms. The data has been gathered and compiled by Ethiopian Central Statistical Agency (CSA). The paper aims at estimating industry-level technical efficiency over time and comparison was made between private and public biscuit and pasta (macaroni) medium and large scale industries, The Central Statistical Agency defines Large and Medium Scale Manufacturing (LMSM) Enterprises in Ethiopia as establishments which engage ten persons and above and uses power-driven machinery.

Both pasta and biscuit industries use the same basic type of raw material and technology, even these products are produced as two product of a single firm for many industries in the sector. Plus output of industries will be taken in value not in unit. So the study utilized panel data sets involving 20 industries for the period of year 2004/05-2008/09.

The study considered industries which have complete data for the consecutive five years to make the data a balanced one. So their efficiency was estimated as aggregate of a single sector but compared as private and public enterprises using econometrics software.

3.2 The Model

3.2.1 Economic Model

The study employed frontier production function fitted as a cost function to estimate technical efficiency of the pasta and biscuit industries. It specified a production frontier proposed by Battese and Coelli (1995) which defines output as a function of a set of inputs together with technical inefficiency of production. The model considers that these inefficiency effects are modeled in terms of other observable explanatory variables and all parameters were estimated simultaneously. The stochastic frontier production frontier for panel data model incorporates the usual stochastic error term which is exogenous to the system and the firm-level effects to be distributed as truncated normal random variables assumed to systematically vary over time. Pioneer representation of the model is as follows:

$$(TC_{it}) = X_{it}\beta + V_{it} - U_{it} \quad \text{for } i = 1,2,\ldots N \text{ and } t = 1,2,\ldots T \qquad (1)$$

where TC_{it} is the total cost of the firm at the time period; X_{it} denotes a $(1xK)$ vector of log of input values and the value of output; β is a $(Kx1)$ vector of unknown scalar parameters to be estimated; Vit are the usual random errors measuring the positive and negative effects of exogenous shocks, assumed to be identically and independently distributed with (0, δ^2) independently of the Uit s; Uit hold no-negative values which are assumed to account technical inefficiency in the model. The summation of the two random variables V_{it} and U_{it} is expressed as e_{it} in which $\sigma_e^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma_e^2$.

3.2.2 Specification of Econometric Model

3.2.2.1 Specification of the Production Function

The stochastic frontier cost function can be specified as a Cobb-Douglas, or translog functional form. The Cobb-Douglas functional form is defined as:

$$\ln TC_{it} = \beta_0 + \sum_{j=1}^{3} \beta X_{jit} + V_{it} - U_{it} \qquad (2)$$

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

$$\ln TC_{it} = \beta_0 + \sum_{j=1}^{3} \beta_j X_{jit} + \sum_{j<k}^{3} \sum_{j<k-1}^{3} \beta_{jk} X_{jit} X_{kji} + V_{it} - U_{it} \qquad (3)$$

where $i = 1,2,...N$ which represents number of firms (N= 20 for pasta and biscuit industries). $t = 1,2...T$ Which represent time period (five years are considered) $j = 1,2,3$ which identify explanatory variables $TCit$ and $Xjit$ denote log of total cost, output and inputs, respectively. The time-variant technical inefficiency effects are non-negative random variables. βs , μ, η , δ^2, $\delta^2{}_v$, $\delta^2{}_u$ are parameters to which were estimated.

This study devoted the stochastic frontier production function fitted in terms of a cost function technique to assess the technical efficiency of manufacturing industry, in particular, the Cobb-Douglas stochastic frontier production with the distributional assumption due to advantages over the other functional forms (Kalirajan and Flinn, 1983; Dawson and Lingard, 1989; Coelli and Battese, 1996, etc.). Since the panel data is used in this study and the sample number is not very high, the translog specification could not be tried.

3. 2.2.2 Specification of Inefficiency model

The model used here incorporates a simple specification of the time-varying inefficiencies following Battese and Coelli (1992) as

$$U_{it} = \{\exp[-\eta(t-T)]\}U_i \qquad (4)$$

where $i = 1,2,\ldots$ and $N = 1,2,\ldots T$

The random variable U_{it} can be considered as technical inefficiency effects for the i^{th} firm in the last period of the panel. Technical inefficiency effects of the firm for earlier periods are assumed to be the product of technical inefficiency effects of the last period and the value of the exponential function, $\exp[-\eta(t-T)]$. If the value of the parameter η had a value greater than zero, then $-\eta(t-T)$ would be greater than zero and the exponential function provides a value not less than one. This shows that earlier periods' technical inefficiency effects are improving over time. But if this parameter has a value less than zero ($\eta < 0$), it implies that technical efficiency declines over time. If this parameter has a value equal to zero ($\eta = 0$) it implies that technical effects of the i^{th} firm does not vary over time, (i.e, $U_{it} = U_i$).

3.3 Estimation Procedure

The parameters of the stochastic frontier model (1) will be estimated using maximum likelihood estimation (MLE). The MLE method has been found to be significantly better than Corrected Ordinary Least Square (COLS) where the contribution of the inefficiency effects of the total variance is large, and is the preferred estimation technique whenever possible (Coelli, Rao and Battese 1998). Using the composed error terms of the stochastic frontier model (1), the total variation in output from the frontier level of output attributed to technical efficiency is defined by $\gamma = \sigma_u^2 / \sigma_e^2$. The variance parameter γ lies on the interval [0, 1].

3.4 Definition and measurement of variables

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. Both measures have their own strengths and weaknesses. Production is the result of the interplay of raw materials, fixed assets and other industrial inputs and it is relatively less affected by measurement errors when calculated at the firm level. Thus, considering gross value of output as a measure of output to be used as a dependent variable is more reasonable.

2. Wage rate for Manual Labor, Wage rate for Non-Manual Labor and salary (X_{1it}**):** In the frontier production, the amount of wages and salaries paid to the workers in each time proxies the labor cost. This is done because labor is a heterogeneous input not only in terms of biological make-up of workers but also in education, work experience and other similar attributes.

Therefore, wages and salaries are presumed to consider such differences and better represent the extent of labor input use.

This variable includes all payments in cash or kind made to the workers during the reference period in connection to the work done for the firms.

3. Industrial cost (X_{2it}): Industrial cost includes raw materials, fuels, electricity and other supplies consumed and industrial services rendered by the firm.

4. Fixed capital (X_{3it}): 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 machinery and equipment and depreciation during the reference period.

5. Total cost (TC_{it}): is an aggregate of fixed cost (fixed capital) and variable cost(wage rate and industrial cost

4 RESULTS AND DISCUSSION

4.1 Descriptive results

4.1.1 Public pasta and Biscuit Industries

Average annual production of public pasta and biscuit industries during 2004/05-2008/09 at industry level was birr 24.1 million. The average wage for employed labor, industrial cost and fixed capital was birr 965.9 thousand, 7.8million and 7.82 million, respectively (Table 1).

Table 1: Descriptive Statistics of Public Pasta and Biscuit Industries during 2004/05-2008/09 (in '000 birr)

Statistics	Wage	Industrial cost	fixed capital	output
Average	965.87	7,802.88	7,816.71	24,142.3
Max	78,668.23	3,705.4	57,877.71	73,637.8
Min	145.034	34.44	101.868	342,134
Stand.dev	20,374.37	994.41	14,262.92	17,219.2

Source: Own calculation based on CSA data

Among the five public pasta and biscuit industries, Dire Dawa food complex had the maximum amount of average production of birr 180.9 million in the time period between 2004/05-2008/09 followed by Kaliti food share company which had birr 118.4 million (Table 2). Dire Dawa food complex also utilized the highest capital and industrial cost of birr 118.8 million and 12 million, respectively. In terms of labor employment, however, Kaliti Food Share Company was the leading, by employing 666 persons.

The minimum average annual producer in the time period considered was Kokeb Flour and Pasta Factory. It produced a value of birr 11.7 million. Kaliti food Share Company had the minimum average industrial cost and fixed capital worth of birr 221.7 thousand and 14.3million, respectively.

In the same period the industry level average annual employment was 404 persons. The highest and the minimum employment were 666 and 134 persons. The average production capacity utilization was 44.5% of the average annual production. Dire Dawa food complex was the only factory which had capacity utilization above 50% while Awash Food Complex was the lowest with 20 %.(Table 2)

Table 2: Descriptive statistics of public pasta and biscuit industries during 2004/05-2008/0 at industry level ('000 birr except for ratios)

Factories	Person employed	Wage	Industrial cost	Fixed capital	Output	Actual capacity-production ratio 2009
Dire Dawa food complex	530	162,684.86	12,009.55	118,847.65	180,884.2	60
Kaliti food share company	666	16,842.6	221.69	14,279.87	118,447.8	50
Misrak Flour and Bakery Factory	404	29,111.14	3,565.83	18,178.76	110,415.8	50
Kokeb Flour and Pasta Factory	288	33,370.164	3,865.976	19,869.301	11,664.4	42.3
Awash Food Complex	134	23,426.24	4,483.82	23,896.43	82,145.2	20

Source: own calculation based on CSA data

4.1.2 Private Pasta and Biscuit Industries

Fifteen private pasta and biscuit industries under consideration had an average annual production, wage and industrial cost of birr 201.3 million, birr 804 thousand and birr 17.9 million, respectively, during 2004/05-2008/09. On average, the industries employed birr 6.7 million worth of fixed capital (Table 3).

Table 3: Descriptive statistics of private pasta and biscuit industries annual performance in the period 2004/05-2008/09 (in '000 birr)

Statistics	Wage	Industrial cost	fixed capital	Output
Total	60,312.1	1,343,990.1	501,483.6	1,472,968.03
Average	804.2	17,919.9	6,686.5	201,253.4
Max	3,581.1	196,199.8	34,194.1	50,173.7
Min	10.3	89.9	3.3	294.8
Stand.dev	872476.1	27936254.1	9440345.1	25,937.7

Source: own calculation based on CSA data

Astco Food Complex Plc had the maximum average annual production of birr 344.7million while Say food complex had the minimum of birr 4.7 million (Table 4).

The average annual employment at industry level for the period considered was 201 persons. The highest and the minimum employment were 435 and 72 persons, in which there was a significant disparity between industrial level employments. During the same year, private pasta and biscuit industries utilized 66.5% of their average annual production capacity on average.

Mars Food Factory was the most efficient industry which had utilized its 95% of capacity of production while the minimum capacity utilization was 35%, which was that of Brothers Flour and Biscuit Factory. Only six industries had more than 80% capacity utilization. In general, private pasta and biscuit industries showed underutilization of production capacity (Table 4).

Table 4: Descriptive statistics of private pasta and biscuit industries during 2004/05-2008/09 at industry level ('000 birr except for ratios)

Factories	Persons employed	Wage	Industrial cost	Fixed capital	Output	Actual capacity-production ratio 2009
Ada Flour and pasta industry	435	10,412,716	137,402,724	50,557,719	115,799.2	85
Abay Pasta and Macaroni Factory	120	12,628,521	178,793,143	123,476,581	28,066.8	89
Afia Food Complex	199	4,912,908	59,850,042	56,321,851	91,828.2	40
Brothers Flour and Biscuit Factory	180	1,846,196	332,045,086	8,675,386	71,958.9	35
Guder Agro-Industry plc	75	1,975,606	46,157,185	53,549,369	59,252.4	60
K.O.JJ. Food Complex	300	3,243,031	94,335,478	115,198,533	122,630.0	79.8
East African Business Group plc	199	4,801,721	207,163,688	19,862,596	180,884.2	83
Universal food complex	105	5,879,498	90,008,720	6,643,592	73,6372	73
AFRICA PLC	127	1,727,294	47,346,610	22,028,838	97,383.5	89.5
Say food complex	72	1,150,781	5,985,466	1,745,038	4,680.2	38.9
T.M Food complex	85	5,418,612	78,063,504	23,022,039	101,104.1	40
Mars food factory	110	781,088	22,479,734	14,766,671	21,546.1	95
Astco Food Complex plc	92	129,025	2,412,085	169,962	344,731.1	50
Nas Foods Factory plc	125	527,450	3,387,422	212,036	108,184.7	47.2
Seka Business Group plc	345	4,877,684	38,559,214	5,253,365	51,281.7	91.9

Source: own calculation based on CSA data

Table 5 describes that there was an increase in annual pasta and biscuit industry production with an average growth rate of 23 % during 2004/05-2008/09. Wage declined by average rate of 16.6% while capital declined at the rate of 7.5%. Partial productivity of labor which shows the value of output produced by one birr of labor increased by 15% and capital which shows the value of output produced by one birr worth of capital increased with average growth rate of 62%.

In public pasta and biscuit industries average annual output increased by 2.6%, in private pasta and biscuit industries while it grew by 23%. Labor and capital productivity showed an increase with an average growth rate of 7% and 1% in public pasta and biscuit industries while the growth in the private industries was 19% and 56%, respectively (Table 5).

Table 5: Partial productivities of pasta and biscuit industries during 2004/05-2008/09(values in '000 birr except for ratios)

Statistics	2004/05	2005/06	2006/07	2007/08	2008/09	Average growth rate
	all industries					
Average wage	787,315	78,799	93,779	93,153	98,045	-16.6
Average fixed capital	7,454.17	9,929.70	7,171.88	7,034.33	4,667.81	-7.5
average output	15,055.6	15,822.4	20,306.8	20,463.8	32,177.7	0.23
output/wage	17.7	17.3	20.2	20.1	29.2	0.15
output/capital	1.7	1.9	2.3	1.9	6.3	0.62
	public industries					
Average wage	787.53	773.48	1090.48	1220.86	957	0.07
Average fixed capital	7016.74	13351.8	7737.85	6265.36	4711.82	0.01
average output	19,3114	88,716.0	109,1749	110,754.7	157,152.9	2.6
output/wage	33.7	28.9	26.9	32.1	35.9	0.03
output/capital	5.2	5.2	5.9	7.7	41.4	1.2
		private firms				
Average wage	945.6	1,015.0	1,068.5	1,125.3	1,100.8	0.04
Average fixed capital	10,495.6	10,232.6	10,392.6	13,514.1	6,485.6	-0.06
average output	13,637.1	15,182.1	19,797.5	19,901.4	29,680.0	0.23
output/wage	14.4	15.01	18.5	17.7	27.0	0.19
output/capital	1.3	1.5	1.9	1.5	4.6	0.56

Source: Own calculation based on CSA data

4.2 Econometric results and discussion

4.2.1 Estimation results

As explained in the model specification sub section, the model that better fits the data is the stochastic frontier production function technique to assess the technical efficiency of manufacturing industry. In particular, the Cobb-Douglas stochastic frontier production with the distributional assumption has advantages over the other functional forms (Kalirajan and Flinn, 1983; Dawson and Lingard, 1989; Coelli and Battese, 1996, etc.). Since the panel data used in this study and the sample number is not very high, the transom specification could not be tried.

The parameters of the stochastic frontier model were estimated using maximum likelihood estimation (MLE). The MLE method has been found to be better than Corrected Ordinary Least Squares (COLS) method, where the contribution of the inefficiency effects of the total variance was large, and hence the preferred estimation technique whenever possible (Coelli, Rao and Battese 1998). MLE methods were used for private and public pasta and biscuit industries. All the coefficients for each input variables and their interaction terms and the parameters ($\gamma, \eta, \mu, \delta^2$) were estimated. The z-ratios for the coefficients and the log likelihood function were also provided. Tables 6 reports these estimation results.

4.2.2 Discussion of Results

4.2.2.1 Pasta and Biscuit Processing Industries

In the MLE of Cobb-Douglas functional form of the pasta and biscuit industries, the coefficients of the labor, industrial cost, output and fixed capital had the expected positive signs. The coefficients of factors of production show the responsiveness of total cost to a unit change in the use of respective input and output. The estimated coefficients show that industrial cost which includes raw materials and other industrial expenses had very significant contribution to the total cost for production of pasta and biscuits.

The coefficient of labor input shows that a unit increase in labor corresponds to a 0.07 unit increase in total cost for output production and it was significant at 5% level. Industrial cost and fixed capital input coefficients are also significant at 5% level.

The significant value of γ (0.16) explains that the share of industry level inefficiency in total output variation attributable to external factors is 16%. It also implies that in the pasta and biscuit industries, inefficiency contributes less to random external factors of production (Table 6).

Table 6: MLE of Cobb-Douglas Production Function for Pasta and Biscuit Industries

Variables	Parameters	ML Estimates	
		Coefficients	z
Constant	βo	2.24	1.49*
Wage(X_{1it})	$\beta 1$	0.066	2.03*
Industrial cost (X_{2it})	$\beta 2$	0.57	19.40*
Fixed capital (X_{3it})	$\beta 3$	0.26	11.01*
Output(X_{4it})	$\beta 4$	0.09	3.14*
Ownership	$\beta 5$	0.18	2.81*
Sigma Square	σ^2	0.09	-16.23*
Gamma	γ	0.16	-2.04*
Mu	μ	2.1	0.99
Eta	η	0.2	2.05*

*Note: * z-value significant at 5% level*

4.2.2.2 Production Efficiency of private pasta and biscuit industries for 2004/05-2008/09

The mean efficiency for private pasta and biscuit industries for the considered period was 0.11, which means 89% inefficiency in production. On average, the private pasta and biscuit industries produce 11% of the maximum attainable output level over the period considered. The deviation from the expected unitary value of efficiency of private pasta and biscuit industries shows the existence of potential for improvement. Which means that, given existing resources and technology, output could be increased by 89% by solving production inefficiency problems.

The maximum average technical efficiency of private pasta and biscuit industries was 0.13, the minimum being 0.10, with slight variation among them. Most of these industries had average efficiency level of 0.1. (Table 7).

Table 7: Mean Production Efficiency of private pasta and biscuit industries for 2004/05-2008/09

Average	0.114
Max	0.127
Min	0.098
Standard deviation	0.009

Source: Own calculation based on CSA data

The average efficiency level increased at the rate of 0.04, implying a slight efficiency increment during the period. The result indicates that the efficiency of the private pasta and biscuit industries increased over the recent few years. This might be because in this time period there was high supply compared to demand of wheat and sugar which are the main inputs for pasta and biscuit production. Other justification might be the past five year industrial policy of the country gives more attention for import substituting industries. There is no as such active exporter of private pasta and biscuit industry in the sector (Table 8).

Table 8: Mean Production Efficiency Trend for private pasta and biscuit industries for 2004/05-2008/09

Efficiency measure	**2005**	**2006**	**2007**	**2008**	**2009**	**Average**
Average efficiency	0.122	0.106	0.110	0.115	0.120	0.114
Growth rate in efficiency	0.038	0.045	0.043	-0.05	0.019	0.038

Source: Own calculation based on CSA data

4.2.2.3 Production Efficiency of Public Pasta and Biscuit Processing Industries

The mean technical efficiency for public pasta and biscuit processing industries for the period under consideration was 0.11, which means inefficiency of 0.88 in production. It also implies that, on average, the Public pasta and biscuit processing Industries produced 11% of the maximum attainable output level over the period under consideration. The highest average technical efficiency of 0.12 and the lowest of 0.10 were attained by these industries (Table 9).

During the period Public pasta and biscuit processing Industries had better average efficiency (0.05) than private counterparts (0.04). Almost all of public industries had more than 10% efficiency level.

This result does not confirm with the descriptive analysis and the hypothesis that private industries have better efficiency than public ones. The possible reason might be in the public industries there is a linkage between state farms with state industries. In the wheat market, which is the main raw material for pasta and biscuit production, there is some state intervention. Public wheat farms sometimes rather than supplying through auction they give priority to public pasta and biscuit producers. This market supply chain might improve public industries' efficiency.

Table 9: Mean Technical Efficiency of public pasta and biscuit industries during 2004/05-2008/09

Average	0.111
Max	0.116
Min	0.102
Standard deviation	0.005

Source: own calculation based on CSA data

The average efficiency level increased at the rate of 0.05, implying a slight efficiency increment during the period. The result indicates that the efficiency of the public pasta and biscuit industries increased over the recent few years (Table 10).

Table 10: Mean Technical Efficiencies Trend in Public Industries during 2004/05-2008/09

	2004/05	2005/06	2006/07	2007/08	2008/09	Average
Average efficiency	0.100	0.105	0.109	0.114	0.119	0.109
Growth rate in efficiency	0.046	0.046	0.042	0.044	-	0.045

Source: Own calculation based on CSA data

5. CONCLUSIONS AND POLICY IMPLICATIONS

Import substituting industries like pasta and biscuit industries which have a potential raw material base can play a vital role for the development of a nation by reducing foreign currency for importing of these products. The availability of diverse ecological zones and labor resources in Ethiopia indicate the potential for the development of pasta and biscuit industries. This sector significantly contributes to the manufacturing sector and its job creation potential is substantial to the economic development of the country. However, the sector has firm level weaknesses as well as external factors hindering its development.

This study has focused on the measurement of technical efficiencies of private and public pasta and biscuit industries in the country over the period of 2004/05-2008/09. It analyzed technical efficiency levels of private and public pasta and biscuit industries over these periods.

A stochastic frontier model, developed by Battese and Coelli (1995), was used to estimate the production of these industries based on panel data of 5 public and 15 private pasta and biscuit industries for the year 2004/05-2008/09. Theories showed that production processes of these industries were better specified as a Cobb- Douglas production function and estimated with maximum likelihood estimation.

The result shows that Private industries had an average annual production growth rate of 23% over the period of 2004/05-2008/09. Industrial cost showed significant contribution to the production of pasta and biscuit as compared to other inputs. These industries used capital-intensive technologies utilizing 66% of their production capacity. There was large disparity among industries in production and in production capacity utilization.

The average technical efficiency for private pasta and biscuit industries was 0.114 and there was an increasing trend over the considered period. This inefficiency results mainly from poor quality of wheat, obsolete machinery, lack of skilled labor and poor managerial skills.

The public pasta and biscuit industries showed an average annual production increment of 260% with the utilization of only 44% of their production capacity. These industries had an average efficiency of 0.11, implying high potential for efficiency improvement. Like the private industries, the public industries' efficiencies had increased over the period 2004/05-2008/09 at the rate of 0.05%.

In general, there exists a potential to increase output in the pasta and biscuit sector by improving efficiency of utilizing the existing resources as well as tackling external problems hindering the development of the sector. These include improvement in the quality of raw materials, better production and marketing system. To improve the quality of wheat supply, the focus needs to start from farm system. The best wheat for better quality pasta production is the Durum type but this variety of wheat has low agricultural productivity per hectare compared to bread wheat variety so that most farmers do not want to produce this type of wheat. Ethiopian Agricultural Research Institute should work to scale up the production of this variety through creating linkage among farmers and processers and compensating farmers for the law productivity by providing price premium. Plus state owned wheat farms should sale their products through auction rather than giving priority to public industries. Moreover, there needs to improve product quality with better packaging and technology, upgrade manpower and managerial skills and other alliances can have considerable effect in development of the sector.

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Appendix 1: Technical efficiencies of private pasta and biscuit industries during 2004/05-2008/09

Company name	**company code**	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**average**
Ada flour and pasta company	1	0.109	0.114	0.119	0.124	0.129	0.119
Abay Pasta and Macaroni Factory	2	0.110	0.115	0.119	0.125	0.13	0.120
Afia Food Complex	3	0.130	0.086	0.090	0.094	0.098	0.100
Brothers Flour and Biscuit Factory	4	0.103	0.094	0.098	0.103	0.108	0.101
Guder Agro-Industry plc	5	0.112	0.123	0.128	0.134	0.139	0.127
K.O.JJ. Food Complex	6	0.144	0.104	0.109	0.114	0.118	0.118
East African Business Group plc	7	0.123	0.103	0.107	0.112	0.117	0.112
Universal food complex	8	0.122	0.086	0.09	0.094	0.099	0.098
Africa pasta PLC	9	0.103	0.106	0.11	0.115	0.120	0.111
Say food complex	10	0.125	0.104	0.108	0.113	0.118	0.114
T.M food complex	11	0.124	0.109	0.113	0.118	0.123	0.117
Mars food factory	12	0.128	0.116	0.121	0.126	0.131	0.124
Astco Food Complex plc	13	0.136	0.115	0.12	0.125	0.13	0.125
Nas Foods Factory	14	0.135	0.100	0.105	0.11	0.115	0.113
Seka Business Group plc	15	0.119	0.108	0.113	0.118	0.122	0.116
Average		**0.122**	**0.106**	**0.110**	**0.115**	**0.120**	**0.114**
Max		**0.144**	**0.123**	**0.128**	**0.134**	**0.139**	**0.127**
Min		**0.103**	**0.086**	**0.090**	**0.094**	**0.098**	**0.098**
St.dev.		**0.012**	**0.011**	**0.011**	**0.011**	**0.012**	**0.009**

Appendix II: Technical Efficiencies of Public pasta and biscuit industries during 2004/05-2008/09

Company name	company code	2004/05	2005/06	2006/07	2007/08	2008/09	average
Dire Dawa food complex	1	0.128	0.106	0.11	0.115	0.12	0.116
Kaliti food share company	2	0.126	0.102	0.107	0.111	0.116	0.112
Misrak Flour and Bakery Factory	3	0.121	0.102	0.107	0.112	0.117	0.112
Kokeb flour and pasta factory	4	0.122	0.100	0.105	0.110	0.114	0.110
Awash food complex	5	0.119	0.090	0.095	0.099	0.108	0.102
Average		**0.123**	**0.100**	**0.105**	**0.109**	**0.115**	**0.111**
Max		**0.128**	**0.106**	**0.110**	**0.115**	**0.12**	**0.116**
Min		**0.119**	**0.090**	**0.095**	**0.099**	**0.108**	**0.102**
St.dev.		**0.004**	**0.006**	**0.006**	**0.007**	**0.004**	**0.005**

Declaration

This thesis is my original work and has not been presented for a degree in any other university, and that all sources of material used for the thesis has been dully acknowledged.

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