ADDIS ABABA UNIVERSITY
SCHOOL OF GRAGUATE STUDIES

Technical Efficiency Analysis of the Ethiopian Leather Sector

BY
GENET ZENEBE

A Project Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment for the Degree of Masters of Art in Economics

JUNE 2009
ADDIS ABABA

ADDIS ABABA UNIVERSITY
SCHOOL OF GRAGUATE STUDIES

Technical Efficiency Analysis of the Ethiopian Leather Sector

BY

GENET ZENEBE

Approved by	**Signature**	**Date**
Dr. Hussien Hamda	----------------	23/06/2008

Acknowledgements

I would like to extend my gratitude to my advisor Dr. Hussein Hamda, for his valuable assistance and constructive advice in the course of preparing this paper. I am also grateful to my husband Ato Berhanu Teshome for his encouragement and support. The credit also goes to my sisters W/o Amsale Zenebe and Dr. Mulumbet Zenebe for their moral support and encouragement.

Table of Contents

Abstract

This study aims at determining the level of technical efficiency of the Ethiopian tanneries and leather foot wear 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 11 tanneries and 28 leather foot-wear industries for the period of 2003-2007. The empirical result indicates that the translog functional form with maximum likelihood estimation better explains the production behaviour of tanneries as well as leather foot-wear industries. It shows that there is significant technical efficiency difference among industries in the sector. The mean technical efficiency of tanneries was 0.77, showing an increasing trend. Poor quality of hides and skins and poor technology are the main constraint of the sector. Among tannery industries, those producing more value-adding products have better efficiency and scale of operation. The average efficiency of leather footwear industries was 0.84, with an increasing trend. Moreover exporting leather footwear industries have better efficiency and scale of operation as compared to non-exporting industries mainly attributed to the production of better quality of product. External constraints including lack of modern marketing skill and financial resources and unfair competition in the domestic market with cheap and less quality of imported products contribute more to the low level of development of the sector. In order to effectively utilize the potential livestock resource and benefit from the good reputation of the leather of the country, efforts have to be made in improving quality of raw hides, infrastructure development, technical and skill development and availability of updated marketing information system. The creation of conducive business environment enhances the sector's development and promotes the competence in the global market competition.

Keywords: Leather sector, stochastic production function, technical efficiency, Ethiopia

JEL Classification: D24, L25, L67.

1. Introduction

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 the Ethiopian National Bank report (2006/2007), the industrial sector has 13% share of GDP and it grew by 11% in the year 2006/2007. The manufacturing sector has 43% share of the industrial sector and the leather industry is one of the four main industries in this sector.

The livestock resource is considered to have a wide base for the leather industry development. The leather sector is labor-intensive and has simple and easily attainable technology which makes it strategic sub-sector for the economic and industrial development in Africa. However, due to factors affecting the development of the sector, its potential for economic growth is far from being fully exploited. According to UNIDO's (2005) strategic plan of the sector, major factors affecting the development of the leather industry include: (i) poor quality of leather emanated from natural defects, man-made defects, poor handling and poor reservation of raw hides and skins; (ii) inadequate supply of hides and skins due to lack of effective collection, in housing usage and low off-take rate; (iii) inadequate level of technological development; (iv) low labour productivity, poor management and outdated training service; (v) high competition in the world market, flourishing of imitation leather product.

According to Ethiopian Tanneries, Footwear and Leather garments manufacturing Association (ETFLMA) (2004), in the world leather market the United States, Germany, United Kingdom, France and Italy are the leading countries which absorb more than 65% of the supply. Ethiopia has comparative advantage in developing the leather industry due to the availability of abundant raw hides and skins and wide large readily available and inexpensive labor pool. According to ETFLMA (2004), the largest number of livestock in Africa and tenth largest in the world is found in Ethiopia. About 70% of the total sheep skin production of the country is concentrated in the highlands. Studies show that skins from this part of Ethiopia have an international reputation for their unique natural substance of fineness, thickness, flexibility, strength and compactness of texture. They are suitable for the production of high quality dress – gloves, sports gloves and garment which have high demand in the world market. According to 2008 report of the Ethiopian Ministry of Trade and Industry, the leather sector is one of the top export commodities in the country. The export earnings from the sector in the year 2006/07 were US $79.7 million with 5.4 % share of the total export of the country. The sector showed an average annual increase of 9% in export earnings from the year 2003 to 2007.

In the leather sector there are tanneries and leather goods processing industries. According to the Ethiopian Textile and Leather Industries Development Centre (ETLIDC) report of 2008, tanneries have more than 80 years of production providing employment opportunities to a large segment of the population. It has also long years of export performance. To date, there are twenty-two tanneries in the country which are all privately owned (ETLIDC 2008). Except one, all are exporting their product which was not the case a decade ago. Tanneries produce in four stages of processing, which are pickle and wet-blue(less- value added products), crust and finished leather (more value-added products).

Leather products include leather footwear, garment, gloves, luggage, bags and other products produced for domestic and international market. Leather footwear is the dominant product of leather products. About 60% of leather footwear input is finished leather while 40% is imported input materials. There are about 50 footwear companies operating in the country. There is fierce competition of leather products in international market due to fashion changes.

The contribution of leather products processing industries including leather footwear to the export sector has not been significant. However, there has been an increasing trend in leather footwear production especially for the export supply in the past few years. Although other leather products do not significantly appear in export trade, the footwear industry has shown great potential for world market penetration of the sector. Currently, there are ten footwear industries in the country producing for international market (MOTI, 2008).

The Ethiopian government, along with its long-term Agricultural Development-Led Industrial Development Strategy (ADLI) which emphasizes the potential advantage of the leather sector, gives policy supports to improve productivity and competitiveness in the international market. At the beginning of 2008, the Ethiopian Textile and Leather Industries Development Centre was established to support the sector, focusing on export product development. The Leather and Leather Products Technology Institute (LLPTI) was also established with the objective of producing trained manpower, conducting research and development activities.

The potential benefit of the leather sector of the country enables to achieve sustainable development through creating jobs, foreign currency earnings and others. This necessitates assessment of the sector's performance. At industrial level, efficiency measures can be used to indicate a benchmark to the relative performance of firms' business operations.

In recent years, tanneries as well as leather footwear industries increase in production focusing on export production. The shift of tanneries production towards more value-adding products points to the possibility of efficiency improvement of the industries. In addition, the government policy based support to the sector to penetrate the world market requires improvement in manufacturing efficiency. There have not been adequate empirical studies tracing the efficiency of the leather sector over time.

With this backdrop, the main objective of this study is to estimate industry- level technical efficiency of tanneries and leather footwear industries and analyze the change in technical efficiency of these industries during the last few years. 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. It was hypothesized that technical efficiencies of tanneries and leather footwear industries have increased over the last few years. Moreover, value-adding tanneries and exporting leather footwear industries are expected to work more efficiently than less value-adding industries and non-exporting leather footwear industries.

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

The rest of the paper is outlined as follows. The next section deals with the review of related literature. Data source and methodology are described in section three. The fourth and the fifth sections discuss the empirical results with descriptive statistics and econometric results respectively. Finally conclusions and policy implications are drawn in the last section.

2. Review of Related Literature

The concept on measuring the efficiency of an institution was first proposed by Farrell (1957). He proposed the concept of economic efficiency to represent total efficiency in an institution, which can be conceptualized as comprising two components which are technical (or technological) efficiency and economic (or allocative) efficiency. Technical efficiency in microeconomics of production is defined as the maximum attainable level of output for a given level of production inputs given the range of alternative technologies available (Ellis, 1993). Alternatively the technical efficiency of a firm may be defined as the ratio of its observed outputs to that which could be produced by the fully efficient firm, given the same input quantities. Allocative efficiency is defined as the ability of a firm to maximize profit by equating marginal revenue product of input to their respective marginal costs. It reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology.

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 levels of output or how efficiently these inputs are utilized over a period of time. Coelli et al. (1998) further argue that productivity can also be technically explained as the combined effect of changes in technical efficiency, technological progress and scale economies. They argue that technological change leads to a shift in the production frontier and derives primarily for investment in research and then adoption of improved varieties and practices. Changing the scale of operation of a firm can also be a factor of productivity change.

The focus of this paper is on technical efficiency which shows how much a firm is off its frontier at any point in time and how quickly it can reach the frontier given certain technology. The seminal work by Farrell (1957) introduced a methodology to measure maximum production rather than average production using production frontiers, which also measure technical efficiency. According to Coelli et al. (1998), production frontier is estimated based on the most efficient observed use of inputs to produce each level of output. It represents the maximum output attainable from each input level reflecting the current state of technology in the industry. Firms operating on the frontier are technically efficient while firms beneath the frontier are less efficient. Technically inefficient firms could increase output without requiring more input. The extent to which firm production (observed output) differs from the frontier (i.e., fully efficient firm) provides a measure of technical inefficiency for each firm. Technical efficiency will take a value between zero and one and hence provides an indicator of technical inefficiency of the firm. A value of one indicates the firm is fully technically efficient.

In the literature the methods used to measure technical efficiency can be broadly classified into two groups based on the approach chosen to estimate the production function of the fully efficient firm, which are commonly known as frontier production function. 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 measure advantage of the non-parametric approach is that it does not impose any functional form on the data, whereas its main disadvantages is its assumption of constant returns to scale.

The parametric approach, even though it imposes functional form on the data, it 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, Translog 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.

Much of empirical analyses have been conducted using stochastic frontier production approach to measure the existence of inefficiency. Among the studies conducted in developing countries that of Walujadi (2004) could be mentioned. He adopted the stochastic frontier production function model, proposed by Battese and Coelli (1995), and estimated the technical inefficiency and its sources for the garment firms. He utilized six-year panel data from 1990 to 1995 for the medium and large-scale garment firms in DKI Jakarta, Indonesia. The estimation result suggested that the Cobb-Douglas functional form was not adequate, and the technical efficiency effects were significant. The empirical results with the translog functional form estimation indicated that export level of production has positive effect on the technical efficiency while size and age of firms had insignificant effect.

Similarly Cororaton et al. (1995) estimated total factor productivity for 25 manufacturing industry firms in Philippines for the period covering years 1956-1992 using stochastic frontier production function and growth accounting methods. In both methods they found that total factor productivity of industries was declining over the considered period. They tried to estimate total factor productivity decomposing it into technical progress and technical efficiency. The stochastic production function using tranlog production function estimation result indicated increment of technical efficiency of these industries (including the leather sector).

Recently, Zahid and Mokhtar (2007) utilized Cobb-Douglas stochastic production frontier in their study to estimate the technical efficiency of Malaysian manufacturing small and medium enterprises for the year 2002. The study considered 56 manufacturing sub sectors 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 areas that were required to further improve the operation of these enterprises.

Among the empirical findings of manufacturing industries in Africa, Ajibefun (2007) considered stochastic frontier production function with application of cross-sectional data. The data covers 180 selected micro enterprises from three major micro enterprises out of the three geographical regions or zones of Nigeria. The results of the analysis showed that the enterprises have varying levels of technical efficiencies across enterprises and across regions. The study indicated consideration of addressing the policy variables (determinants of technical inefficiency) in order to increase the current level of technical efficiency and enhance the productivity in the informal sector of the economy.

In Ethiopia, a number of efficiency studies have been conducted but most of them concentrate in crop production sector of agriculture. There are limited efficiency studies in the livestock sector in general and the leather products in particular. Among few, Worku (2001) estimated the technical efficiency of leather industries using stochastic frontier production function model. He used panel data of 10 tanneries and 24 leather product industries to estimate technical efficiencies of the tanneries and leather product industries independently. He found that tanneries and leather product industries are inefficient with declining trend. His test demonstrated that there is statistically valid technical efficiency differential among tanning industries while shoe and other leather processing industries were operating more or less on a similar level of technical efficiency.

Similarly, Daniel (2005) also conducted a study to measure technical efficiency among the Ethiopian manufacturing industries and analyzed 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 all the industrial group in the considered period. In the study, the leather sector is one of the industrial groups which showed significant inefficiency differential among the firms with mean technical efficiency of 0.74, with a declining trend. Moreover, he found that firm size had positive effect in increasing the efficiency of the leather sector, a result similar to an earlier study by Worku (2001).

More recently, Jemal (2008) estimated total factor productivity and competitiveness of Ethiopian textile and garment industries for the year 2001-2005 using stochastic frontier production function and unit-cost ratio method. The analysis showed that there was a decline in technical efficiency and total factor productivity over the period contributing to domestic and international uncompetitiveness in the sector. Earlier empirical works by Getnet and Admit (2001) and Worku (2001) using unit cost ratio method showed that, in general, the manufacturing sector has poor competitiveness and the leather sector was inefficient and uncompetitive.

The leather industries utilize more or less the same technology which leads us to measure the current technical efficiency difference of industries to investigate the productivity behaviour. The model specified in the literature enables us to measure the trend of current industrial production technical efficiency of the sector

3. Research Methodology

The data source of the study is the Ethiopian Central Statistical Agency. Due to the difference in operation and level of technology in tanning and leather footwear industries, the study utilizes two different panel data sets involving 11 and 28 leather footwear industries for the period of year 2003-2007. The study considered industries which have complete data for the consecutive five years to make the data a balanced one. The study aims at estimating industry-level efficiency over time in tanneries and leather footwear industries independently using panel data using Frontier software. The efficiency difference between more value-adding tanneries (crust and finished leather producing) and the less value-adding tanneries (pickle and wet blue producing) is also analyzed. Among all leather products producing industries, only leather footwear producing industries are considered in this study. Analysis of the efficiency difference between exporting industries and non-exporting leather footwear industries is also included in the study. Model specification and empirical results with descriptive statistics and econometric results of the study are presented in detail.

3.1 Model specification and description of variables

3.1.1 Model specification

The study employed frontier production function to estimate technical efficiency of the tanneries and leather footwear industries. The model specifies a production frontier proposed by Battese and Coelli (1995) which defines output as a function of 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 are 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 which are assumed to systematically vary over time. The generic representation of the model is as follows:

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

where Yit is the output of the firm at the time period; Xit denotes a $(1xK)$ vector of log of input values; 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 $\gamma = \sigma_u^2 / \sigma_e^2$.

Technical efficiency of the firm in the t time period is defined by

$\mathrm{TE}_{it} = \exp(-U_{it})$. It measures the extent to which a certain firm operates below the frontier drawn by the amount most efficient firm among the sample firms 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 firms has persistent nature and is time irresponsive. However, this study considers that technical inefficiency changes over time. The technical inefficiency effect as a function of time is defined as:

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

where $i = 1,2,...$ and $N = 1,2,...T$

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., $U_{it} = U_i$).

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

The Cobb-Douglas functional form is defined as:

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

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

$$y_{it} = \beta_0 + \sum_{j=1}^{3} \beta_j X_{jit} + \sum_{j<k}^{3} \sum_{j<k-1}^{3} \beta_{jk} X_{jit} X_{kji} + V_{it} - U_{it} \qquad (4)$$

where i= 1,2,...N which represents number of firms ($N = 11$ for tanneries and 28 for leather footwear industries). $t = 1,2...T$ which represent time period (five years are considered) $j = 1,2,3$ which identify explanatory variables yit and $Xjit$ denote log of 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 be estimated.

3.1.2 Definition and measurement of variables

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. 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. Wages and salaries (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 machineries and equipment and depreciation during the reference period.

4. Results and Discussion

4.1 Descriptive results

4.1.1 Tanneries

As shown in Table 1, the 2003-2007 average annual production of tanneries at industry level was birr 62.6 million. The average employed labor, industrial cost and fixed capital were birr 2.9 million, birr 43 million and birr17.6 million, respectively. All tanneries were engaged in export and the average annual earning was birr 40.7 million. The export had a 65% share of the average annual tannery production (Table 1).

Table 1: Descriptive Statistics of Tanneries during 2003-2007 (in '000 birr)

Statistics	**Wage**	**Industrial cost**	**fixed capital**	**output**	**export**
Total	31,844	475,239	193,164	688,563	448,160
Average	2,895	43,204	17,560	62,597	40,742
Max	11,997	144,378	60,442	246,545	108,003
Min	411	3,967	1,583	4,685	3,198
Stand.dev	3,766	40,215	18,613	68,304	32,349

Among the eleven tanneries, Elico Awash Tannery had the maximum amount of average annual production of birr 246.7 million in the considered period. This tannery employed the highest labor, capital and industrial cost. It also had the highest annual export of birr 108 million, which is 44% of its production and 24% of the total export. The minimum average annual production birr 4.7million was that of Hafde (Haji Feyissa Degaga) PLC. Walia Tannery exported the highest share of its production (i.e., 99%) while Shoa tannery had the lowest (20%) export share of its production. There was significant difference in the scale of operation amount of input utilized and export level between industries.

In year 2007, the average annual employment at industry level was 259 persons. The highest and the minimum employment was 730 and 40 showing a significant disparity between industries. During the same year, the average production capacity utilization was 78% of the average annual production. Dire Industries is the only tannery which had 100% capacity utilization while Shoa Tannery was the lowest 27%. The tanneries had large variation in utilizing their production capacity (Table 2).

Table 2: Descriptive Statistics Result on Tanneries at Industry Level in Year 2003-2007 ('000 birr except for ratios)

Factories	Person employed	Wage	Industrial cost	Fixed captal	Output	Export	Export/ Prod ratio	Actual / Capacity ProdRatio (2007)
Elico Awash Tannery	730	11,997	144,378	60,442	246,545	108,003	44	60
Kombolca Tannery	99	7,941	61,449	38,282	101,525	54,910	54	93
Ethiopia Tannery	693	2,194	74,941	34,786	92,967	74,911	81	82
Addis Ababa Tannery**	329	1,135	50,695	12,185	63,017	61,617	98	
Dire Industries PLC.	262	1,341	36,584	8,178	45,108	41,989	93	100
Walia Tannery PLC.	214	4,97	32,532	1,583	35,837	35,597	99	86
Hora Tannery	108	668	30,484	5,917	34,364	33,251	97	48
Shoa Tannery	40	4,107	13,565	10,948	30,379	6,126	20	27
Jafar Enterprise (Tikur Abay)	58	1,069	16,216	4,471	20,516	18,955	92	55
Dessie Tannery	52	411	10,428	8,861	13,621	9,602	70	68
Hafde (Haji Feyisa Degaga) PLC.	261	483	3,967	7,511	4,685	3,198	68	69
Total	2.846	31,844	475,239	193,164	688,563	448,160	65	
Average	259	2,895	43,204	17,560	62,597	40,742	65	78
Max	730	11,997	144,378	60,442	246,545	108,003	99	100
Min	40	411	3,967	1,583	4,685	3,198	20	27
St.Dev	244,3	3,766	40,215	18,613	68,304	32,349	26	22

** **Production capacity utilization figure unavailable**

Of the eleven tanneries, six produced the more value-added products (crust and finished leather producing) in the considered time period. They had much better scale of production and input resource use as compared to the five tanneries which produce less value-added products (pickle and wet blue products). They also had a total average annual export value of birr 377 million, which was 84% of the total average annual export of tanneries. It indicates the tanneries' focus towards export-oriented production. Labor and capital were more productive in more value-added producing tanneries than the pickle and wet blue producing tanneries, as can be seen from their output /wage ratio and output/capital ratios. The capital-to-wage ratio in these industries indicates that more value-adding tanneries are more capital-intensive than pickle and wet blue producing tanneries (Table 3).

Table 3: Descriptive Statistics Result on More Value Added and Less Value Added Producing Tanneries in Year 2003-2007('000birr except ratios)

Industry Types	Statistic	Wage	Industrial cost	Fixed capital	Output	Output/ wage ratio	Output/ capital ratio	Capital/ wage ratio
More value added producing	Total	25,105	400,579	155,455	584,998	23.3	3.8	6.2
	Average	4,184	66,763	25,909	97,500	23.3	3.8	6.2
	Max	11,997	144,378	60,442	246,545	72.1	22.6	15.9
	Min	497	32,532	1,583	35,837	12,8	2.7	3.2
	standard deviation	4,692	41,134	22,445	77,443	22.1	77	4.8
Less value added producing	Total	6,738	74,660	37,709	103,565	15,4	2.7	5.6
	Average	1,348	14,932	7,542	20,713	15.4	2.7	5.6
	Max	4,107	30,484	10,948	34,364	51.5	5.8	21.5
	Min	411	3,967	4,471	4,685	7.4	0.6	2.7
	standard deviation	1,564	9,822	2,521	12,114	18.3	2.1	7.9

Table 4 depicts that there was an increase in annual tannery production with an average growth rate of 24% during 2003-2007. Wage grew by average rate of 6% while capital declined at the rate of 4%. Partial productivity of labor and capital which shows the value of output produced by one birr worth of labour and capital has also increased with average growth rate of 22% and 30%, respectively.

In more value-adding tanneries average annual output growth was 30% while it was only 3% in less value-adding tanneries. Labor and capital productivity showed an increase with an average growth rate of 27% and 42% in more adding industries while they declined at rates of 3% and 8%, respectively, in less value-adding industries (Table 4).

Table 4: Partial Productivities of Tanneries during 2003- 2007 (values in '000birr except the ratio)

	2003	2004	2005	2006	2007	average growth rate
			all industries			
Average wage	2,719	2,230	3,033	3,329	3,164	5.71
Averagefixedcapital	19,270	17,682	17,452	17.220	16,178	-4.23
average output	51200	48,714	59,421	52,977	100,671	24.08
output/wage	0,02	0.02	0.020	0.016	0.032	21.73
output/capital	0,003	0.003	0.003	0.003	0.006	29.97
			more value adding industries			
Average wage	4,007	3,129	4,349	4,664	4,772	6.66
Averagefixedcapital	29,895	27,009	23,776	25,968	22,898	-6.06
average output	75,853	77,072	84,614	78,462	171,497	30.67
output/wage	0.02	0.02	0.019	0.017	0.036	27.30
output/capital	0.003	0.003	0.004	0.003	0.007	42.49
			less valueadding industries			
Average wage	1,173	1,150	1,454	1,728	1,233	3.68
Averagefixedcapital	6,520	6,489	9,863	6,721	8,115	10.10
average output	2,617	14,684	29,189	22,395	15,681	3.36
output/wage	0.02	0.01	0.020	0.013	0.013	-2.70
output/capital	0.003	0.002	0.003	0.003	0.002	-7.60

4.1.2 Leather footwear industries

The twenty eight leather footwear industries under consideration had an average annual production, wage and industrial cost of birr 6.4 million, birr 792 thousand and birr 4.4 million, respectively, during 2003-2007. On average, these industries employed birr 5.6 million worth of fixed assets.

Among the twenty eight leather footwear industries, six industries were engaged in the production for export market. The average annual export of all the six industries was birr 13.2 million, which accounts for only 7% of the average annual production of all the industries (Table 5).

Table 5: Descriptive Statistics of Leather Footwear Industries Annual Performance in Year 2003-2007 ('000 birr)

	Wage	Industrial cost	Fixed capital	Output	Export
Total	22,189	122,129	157,735	179,874	13,228
Average	792	4,362	5,633	6,424	472
Max	6,806	21,270	13,374	39,676	8,487
Min	14	122	26	139	0.33
st.dev	3,766	5442	4,088	8,463	1,665

There was significant difference in the scale of operation and amount of inputs utilized among the industries. Tikur Abay Shoes Factory had the maximum average annual production of birr 39.7million while Korem Shoe factory had the minimum of birr 139.4 thousand. The six exporting industries, on average, had 15% of their product engaged in export. Moreover, the leading three industries in average annual production had 92 % share of the total export, which indicates that exporting industries showed relatively better performance compared to others.

In year 2007, the average annual employment at industry level was 232 persons. The highest and the minimum employment were 794 and 6 persons, in which there was a significant disparity between industrial level employments. Among the five leather footwear industries, which were engaged in 200 and more employees, four of them were exporters. This suggests that export-oriented industries were engaged mostly in large scale production compared to others. During the same year, leather footwear industries utilized 57% of their average annual production capacity on average. Dire Industrial P.LC. was the only industry which had utilized its full capacity production while the minimum capacity utilization was 11%, which was that of Ruskuo Shoe and Plastic Industry. Only four industries had more than 80% capacity utilization. In general, leather footwear industries showed significant underutilization of production capacity and there was high disparity among the industries in capacity utilization (Table 6).

Table 6: Descriptive Statistics of Leather Footwear Industries' Annual Performance during 2003-2007 ('000birr)

No	Factories	Person Employed	Wage	Industrial cost	Fixed capital	Output	Export	Actual / Capacity Prod ratio (2007)
1	Anbessa Shoes Share Company	794	6112	13331	9072	24967	1039	84
2	Tikur Abay Shoes Factory	514	6806	21270	11406	39676	2629	75
3	Ethiopian Canvas & Plastic Shoes Factory	345	1974	2713	5303	4958		31
4	Jamaica Shoes	36	187	1711	506	2437		28
5	Wabe Shoes Factory	30	69	696	2199	926		74
6	Data Rapid Shoes	33	134	429	2484	865	8.8	45
7	Melesse Taka Shoes	15	40	148	397	235		69
8	Ruskuo Shoe & Plastic	23	299	3047	12316	5378	0.3	11
9	Marfeil P.L.C.	56	257	6146	13374	5694		75
10	Addis Foot Wear	102	695	5406	1309	7451		28
11	Kangaroo Shoe Factory	162	957	5269	8771	9106		34
12	Mk Trade & Industry	47	246	7162	10962	10024		83
13	Pu. Pvc Shoe Sole	34	165	1074	3049	1437		34
14	Ramsay Shoe Factory	303	47	3301	1756	3699	1065	50
15	Kangaroo Sole Factory	51	693	3359	5456	5674		23
16	Z Farm Star P.L.C.	64	337	7270	12488	10990		86
17	Likie Plastic & Shoes	82	243	1799	5393	3256		67
18	Katiso Canvas & Plastic Factory	58	323	4980	7575	6936		50
19	Desta P.L.C.	62	284	5151	7743	6504		55
20	Tosa Plastic Shoe Factory	41	52	1262	3180	2086		67
21	COmfort Plastic Shoe Factory	76	369	1756	5152	2570		20
22	Fd P.L.C. (Dekadeab Gosheme And His Friends)	16	39	636	4920	1007		75
23	Gindo Industrial Trading P.L.C. **	40	97	2058	8840	4286		
24	Hora Techno Plastic Factory	18	99	275	473	483		58
25	Dire Industrial P.L.C. (Peacock Shoe Factory)	243	1371	19850	5944	15936	8487	100
26	Korem Shoe Factory	6	14	122	26	139		38
27	Bahir Dar (Sirak & Meseret) Plastic Shoe Factory	20	129	817	1553	1491		75
28	Birhanu & His Families Plastic Products Manufacturing	86	153	1093	6083	1664		69
	Total	3,357	22189	122,129	157,735	179,874	13,228	57
	Average	232	792	4362	5633	6424	2.2	57
	Maximum	794	6,806	21,270	13,374	39,676	8,487	100
	Minimum	6	14	122	26	139	0.3	11
	Standarddevation	177	1,662	5,442	4,088	8,463	3,224	24

** Capacity utilization figure is not available.

The six leather footwear industries which were engaged in export had 50% share in total production. They had better scale of production and labor and industrial cost use as compared to the non exporting leather foot wear industries. Regarding fixed assets, the average annual fixed assets of exporting countries at industry level (birr 7.2 million) was also higher than that of the non-exporting industries (birr 5.2 million).

At industry level, capital was more productive in exporting industries while labour was more productive in non-exporting industries. Capital to wage ratio showed that the non-exporting industries were more capital-intensive than exporting industries with large variation between the maximum and the minimum (Table 7).

Table 7: Descriptive Statistics of Exporting and Non-Exporting Leather Footwear Industries in 2003-2007('000 birr except for ratios)

Type of Industries	Statistics	Wage	Industrial cost	Fixed capital	output	Output/ wage ratio	Output/ capital ratio	Capital/ wage ratio
Exporting industries	Total	14,767	61,227	42,979	90,522	6.1	2.1	2.9
	Average	2,461	10,205	7,163	15,087	6.1	2.1	2.9
	Max	6,806	21,270	12,316	39,676	79.1	3.5	41.2
	Min	47	429	1,756	865	4.1	0.3	1.5
	Stand.dev	3,140	9,162	4,491	15,028	29.0	1.3	18.1
Non-Exporting industries	Total	7,422	60,901	114,755	89,352	12.0	0.8	15.5
	Average	337	2,768	5,216	4,061	12.0	0.8	15.5
	Max	1,974	7,270	13,374	10,990	44.2	5.7	126.2
	Min	14	122	26	139	2.5	0.2	1.9
	Stand.dev	438	2,384	3,980	3,320	12.4	1.6	31.3

Table 8 shows that there was an increase in average annual leather footwear production with a rate of 12% during 2003-2007. Wage increased with an average growth rate of 5% while capital declined at the rate of 2%. Partial productivity of labor and capital, which shows the value of output produced by one birr worth of labor and capital, had increased with average growth rate of 7 % and 15%, respectively.

Exporting industries showed higher average annual output growth (16%) than the non-exporting industries (9%), the difference being almost double. Non-exporting industries are more capital-intensive than exporting industries. The rate of growth had been declining in non-exporting industries but increasing for exporting ones. Labor productivity was better in exporting industries while capital productivity was better in non-exporting ones (Table 8).

Table 8: Partial Productivity Trend in Leather Footwear Industries during 2003-2007 (in '000 birr, except for the ratios)

Statistics	2003	2004	2005	2006	2007	average growth rate
	All industries					
Average wage	707	769	809	824	853	4.8
Averagefixedcapital	6,213	5,905	5,543	4,854	5,652	-1.8
average output	5,172	6,259	6,305	6,325	8,060	12.4
output/wage	7.3	8.1	7.8	7.7	9.4	7.1
output/capital	0.8	1.1	1.1	1.3	1.4	14.7
	Exporting industries					
Average wage	2,197	2,475	2,482	2,586	2,567	4.1
Averagefixedcapital	7,064	7,837	7,096	5,215	8,604	10.0
average output	11,736	13,009	14029	15620	21,040	16.2
output/wage	5.3	5.3	5.7	6.0	8.2	12.1
output/capital	1.7	1.7	2.0	3.0	2.4	13.0
	Non-exporting industries					
Average wage	301	304	353	344	386	6.7
Averagefixedcapital	5,981	5,377	5,120	4,755	4,846	-5.0
average output	3,382	4,417	4,198	3,790	4,520	8.8
output/wage	11.3	14.5	11.9	11.0	11.7	2.5
output/capital	0.6	0.8	0.8	0.8	0.9	14.8

4.2 Econometric results and discussion

This section reports estimated parameters, tests some hypotheses and discusses the estimation results of tanneries and leather footwear industries.

4.2.1 Estimation results

In order to select the model that better fits the data, the two alternative frontier models, namely, the Cobb-Douglas and the translog production frontiers were estimated. Ordinary Least Square (OLS) and Maximum Likelihood Estimation (MLE) methods were used independently for tanneries and leather footwear industries. All the coefficients for each input variables, their quadratic and interaction terms and the parameters ($\gamma, \eta, \mu, \delta^2$) were estimated. The t-ratios for the coefficients and the log likelihood function were also provided. Tables 9 and 10 report these estimation results. In addition, the estimated technical efficiencies of the two industries are shown in Tables 13-16.

Table 9: MLE of Cobb-Douglas and Translog Production Functions for Tanneries

Variables	Parameters	Coubb-Douglas Model				Translog model			
		OLS Estimates		ML Estimates		OLS Estimates		ML Estimates	
		Coeffecients	T-ratios	Coeffecients	T-ratios	Coeffecients	T-ratios	Coeffecients	T-ratios
Constant	βo	8.1123	6.0202**	10.2965	7.3029**	-6.1000	-0.5082	-12.3336	-1.2993
Wage(X_{1it})	$\beta 1$	-0.0012	-3.3002**	-0.0012	-5.7086**	-0.00097	-4.8110**	-0.0010	-5.5462**
Indstrial cost (X_{2it})	$\beta 2$	0.6675	7.2482**	0.5550	5.5611**	1.4574	0.8798	2.5969	1.8709*
Fixed capital (X_{3it})	$\beta 3$	0.0004	1.2073	0.0006	2.6836**	0.0016	0.9527	0.0028	2.0276*
$X_{1it} * X_{1it}$	$\beta 11$					0.6322	10.3745**	0.5002	7.7066**
$X_{2it} * X_{2it}$	$\beta 22$					0.0002	0.9721	0.0002	10.7734**
$X_{3it} * X_{3it}$	$\beta 33$					0.0111	0.1274	0.0067	0.9446
$X_{1it} * X_{2it}$	$\beta 12$					-0.00004	-0.2018	-0.0001	-0.7516
$X_{1it} * X_{3it}$	$\beta 13$					-0.0398	-0.6921	-0.0806	-1.6980
$X_{2it} * X_{3it}$	$\beta 23$					0.0001	0.4461	-0.00005	-0.2297
Sigma Square	σ^2	0.5577		2.5598	0.4258		0.1693	0.8167	1.3205
Gamma	γ			0.9365	6.2052**			0.8991	10.0806**
Mu	μ			-1.7900	-0.2194			-1.7138	-1.6979
Eta	η			-0.0361	-0.8754			0.0007	0.0111
log likelihood function	LF		-59.9090		-40.6975		-23.6823		-17.8470

Note: ** and* are t-values significant at 5%and 10% level respectively

Table 10: MLE of Cobb-Douglas and Translog Functions for Leather Footwear Industries

Variables	Parameters	Coubb-Douglas model				Translog model			
		OLS Estimates		ML Estimate		OLS Estimates		ML Estimate	
		Coeff.	t-ratios	Coeff.	t-ratios	Coeff.	t-ratios	Coeff.	t-ratios
Constant	βo	5.4482	9.4434**	6.6967	8.6657**	1.6287	0.9596	2.3822	1.2766
Wage(X_{1it})	$\beta 1$	-0.0008	-3.2696**	-0.0010	-7.7295**	-0.0009	-7.940**	-0.0009	-8.3407**
Industrial cost (X_{2it})	$\beta 2$	0.7669	17.0457**	0.7656	11.6631**	0.1100	0.3776	0.0642	0.2158
Fixed capital(X_{3it})	$\beta 3$	0.0005	2.0283**	0.0007	4.3096**	0.00005	0.1452	-0.0003	-0.0827
$X_{1it} * X_{1it}$	$\beta 11$					0.6854	17.6321**	0.6342	12.0348**
$X_{2it} * X_{2it}$	$\beta 22$					0.0007	6.0736**	0.0007	6.0454**
$X_{3it} * X_{3it}$	$\beta 33$					0.0987	3.2710**	0.1265	3.8845**
$X_{1it} * X_{2it}$	$\beta 12$					-0.00002	-0.1428	0.000002	0.0219
$X_{1it} * X_{3it}$	$\beta 13$					0.0028	0.2513	0.0049	0.4288
$X_{2it} * X_{3it}$	$\beta 23$					0.0002	1.9707**	0.0002	2.2939**
Sigma Square	δ^2	0.6070		0.7379	2.8013**	0.1262		0.1199	2.1582**
Gamma	γ			0.7922	10.1944**			0.2561	0.7664
Mu	μ			1.0997	3.0528**			-0.0881	-0.1327
Eta	η			0.0013	0.0745			0.2384	1.5203
log likelihood function	LF		-161.6851		-105.2690		-48.5720		-41.8023

Note: **,* are t-values significant at 5%and 10% level respectively.

4.2.2 Hypothesis Testing

The first hypothesis refers to the selection of the adequate functional form which better represents the production function of the tanneries and leather footwear industries among the two (Cobb-Douglas and translog) functional forms. This hypothesis is tested using log likelihood ratio test based on the maximum likelihood estimation value of the two models. The log likelihood ratio statistic λ is given by:

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

where $\ln L(Ho)$ is the value of the likelihood function for the frontier model in which the null hypothesis are imposed (Cobb-Douglas function) and $\ln L(H_1)$ is the value of likelihood function for the general frontier function (trans log function).

The null hypothesis constrains the existence of all the interaction terms between explanatory variables. It disregards the effect of the interaction between wage and industrial cost, wage and fixed capital, fixed capital and industrial cost and the effect of the square of each of these three inputs where $H_0 = \beta_{11}, \beta_{12}, \beta_{22} = 0$. We accept the null hypothesis if $\lambda < \chi 2(r)$, where (r) is the number of restrictions. In our case we have 6 restrictions (all interactions and quadratic terms). 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 industries.

As shown in Table 11, the log likelihood ratio test statistic λ for the tanneries was -2[-40.70-(-17.85)] = 45.7, which is significant at 5% significance level (the tabular value with $\chi^2(6)$ is

12.59). Therefore the null hypothesis is rejected and the functional form which better explains the tanneries production was the translog function.

For the leather footwear industries the log likelihood ratio test statistic λ with 6 degree of freedom was -2[-105.27-(-41.80)] = 126.94 which is also significant at 5% level. Therefore we reject the null hypothesis and accept the alternate hypothesis implying that the translog functional form better specifies the leather footwear industries (Table 11).

Table 11: Functional form selection test

Industry	**Cobb-Douglas** (H_0)	**Translog** (H_A)	$\chi 2$ **cal**	$\chi^2(6)0.95$
Tannery	-40.70	-17.85	**45.7***	12.59
Leather Footwear	-105.27	-41.80	**126.94***	12.59

* Significant at 5% level of significance

The second hypothesis to be tested was to identify if there was tangible inefficiency among industries during the specified period. The null hypothesis was that $Ho = \gamma = \mu = \eta = 0$ implying that there was no significant inefficiency differential among the industries and the operation of the industry would be better characterized by OLS. The alternative hypothesis is, $HA \neq \gamma \neq \mu \neq \eta \neq 0$. For tanneries with the selected translog functional model, the computed log-likelihood ratio test statistic λ was -2[-23.68-(-17.85)] =11.67, which was significant at 5% significance level (the tabular value with $\chi^2(3)$ being 7.81). Therefore, the null hypothesis can be rejected, implying that there is statistically valid technical efficiency difference among tanneries and the average production function was an inadequate representation of tanneries' production functions. The leather footwear industries with the selected translog functional model had log likelihood ratio test statistic λ with 3 degree of freedom of -2[-48.57-(-41.80.)]

= 13.54, which is also significant at 5% level. Therefore, we can reject the null hypothesis and accept the alternate hypothesis implying that the MLE better estimates the underlying production function (Table 12).

Table 12: Estimation procedure selection test

Industry	OLS	MLE	$\chi 2$ cal.	$\chi 2(3)0.95$
Tannery	-23,68	-17,85	**11,67***	7.81
Leather footwear	-48.57	-41.80	**13.54***	7.81

* Significant at 5% level of significance

The mean technical efficiency using Frontier software for tanneries with the translog functional form as well as for the leather footwear industries with the Cobb-Douglas functional form is performed for the year 2003-2007 (Tables 13-16).

4.2.3 Discussion of results

4.2.3.1 Tanning Industries

In the MLE of translog functional form of the tanneries, the coefficients of the industrial cost and fixed capital have the expected positive signs while labor has a negative sign. The coefficients of factors of production show the responsiveness of output to a unit change in the use of respective input. The estimated coefficients show that industrial cost which includes raw materials and other industrial expenses had very significant contribution to the production of tanneries.

Labor input coefficient shows that a unit increase in labor corresponds to a very slight (0.001 unit) decrease in output and it was significant at 5% level while industrial cost and fixed capital input coefficients are significant at 10% level. This negative impact of labor on the level of output could be due to a large amount of labor that is employed on a relatively small amount of capital. The coefficient of the labor squared variable was significant while the coefficients of the squared terms of the rest inputs and all the coefficients for the interaction of each of the inputs were insignificant. The unexpected sign and the insignificance of the coefficients can be attributed to the nature of the translog functional form which brings the multicolinearity problem arising from the inclusion of squared or quadratic form and cross-products of the input variables. However, since the purpose of the study is to predict efficiency, multicolinearity will not be a serious problem and some degree of multicolinearity can be tolerated (Maddala, 1992). In the translog model, elasticities with respect to each input cannot be calculated easily as in the case of Cobb- Douglas production function.

The significant value of γ (0.90) explains that the share of industry level inefficiency in total output variation attributable to both internal and external factors is 90% and is substantial. It also implies that in the tanneries, inefficiency contributes more to the deviation of the production function from the best production frontier line as compared to the external factors of production. This inefficiency factors are more likely to arise from poor quality of hides and skin, obsolete machinery, unskilled labor and poor managerial skill (Table 9).

The mean efficiency for tanneries for the considered period is 0.77, which means 23% inefficiency in production. On average, the tanneries produce 77% of the maximum attainable output level over the period considered. The deviation from the expected unitary value of efficiency of tanneries shows the existence of potential for improvement. That is, given existing resources and technology, output could be increased by 23% by tackling production inefficiency problems.

The maximum average technical efficiency of tanneries was 0.93, the minimum being 0.33, with slight variation among them. On average, the tanneries had 0.6 more average efficiency every year while only one factory, i.e., Jafar (Tikur Abay) enterprise had 0.33 average efficiency level. This industry is categorized in less value-adding tannery and is one of the low-scale producing tanneries.

During the period under consideration, more value-adding tanneries had mean efficiency of 0.86 while less value-adding tanneries had 0.65. What is intriguing is that the minimum efficiency of the more value-adding tanneries (0.77) was almost equal to the maximum efficiency of the less value-adding tanneries (0.79). Mean efficiency level of more- value adding tanneries ranges from 0.77 to 0.93 while it was 0.33 to 0.78 for less-value adding tanneries. This suggests that more value-adding tanneries perform more efficiently than the less value-adding ones (Table 13).

Table 13: Mean Production Efficiency of Tanneries for the Year 2003-2007

Statistics	More value-adding tanneries	Less value-adding tanneries	All tanneries
Average	0.863	0.653	0.767
Max	0.927	0.785	0.927
Min	0.765	0.334	0.334
Standarddeviation	0.073	0.193	0.172

The average efficiencies of all tanneries had been increasing from 0.7669 to 0.7674 during the period 2003--2007 with nearly a constant pace every year. The average efficiency level increased at the rate of 0.017, implying a slight efficiency increment during the period. The rate of efficiency increase was slightly higher in less value-adding tanneries (0.017) than in more value-adding tanneries (0.010). This increment goes with the estimated result of η (0.00072), which was positive and implying minimum efficiency increase of tanneries over the years. But its test statistics 0.011 is not significant at 5% significance level. This might occur because of the increase in the efficiency of tanneries over time was very minimal. The result which indicates that the efficiency of the tanneries increased or improved over the recent few years is in line with the hypothesis of the study, which states improvement in technical efficiency of tanneries during the period (Table 14).

Table 14: Mean Production Efficiency Trend for Tanneries during 2003-2007

Efficiency measure	2003	2004	2005	2006	2007	Average
Average effeciency	0.7669	0.7670	0.7671	0.7673	0.7674	0.7671
Growth rate in efficiency		0.0169	0.0168	0.0168	0.0168	0.0168

4.2.3.2 Leather footwear industries

In the translog production frontier the estimated labor coefficient for the leather footwear industries was negative and significant at 5% level while that of the industrial cost and fixed capital were insignificant (Table15).

The estimated γ value (0.26) indicates that the share of firm level inefficiency in the total output variation attributable to both internal and external factors was about one fourth. It implies that external factors contribute more to the deviation of the production of output from the best production scheme. As mentioned in the descriptive part, on average, the leather footwear industries utilize only 57% of their capacities. Imported cheap and less quality (imitation and synthetic) shoes, which dominate the domestic market, lack of better technology and financial resources could be mentioned as external factors affecting these industries.

The mean technical efficiency for leather footwear industries for the period under consideration was 0.84, which means inefficiency of 0.16 in production. It also implies that, on average, the leather footwear industries produce 84% of the maximum attainable output level over the period under consideration and there is potential for improvement. The highest average technical efficiency of 0.94 and the lowest of 0.58 were attained by non-exporting industries.

During the period, exporting leather footwear industries which produced better-quality products had better average efficiency (0.85) than their non-exporting counterparts (0.83). All exporting industries had more than 80% efficiency level except one industry which had 65%. (Table15). This result confirms the hypothesis that exporting leather footwear industries have better efficiency than non-exporting ones.

Table 15: Mean Technical Efficiency of Leather Footwear Industries during 2003-2007

	Exporting Industries	Non-exporting Industries	All industries
Average	0.852	0.834	0.838
Max	0.937	0.943	0.943
Min	0.648	0.582	0.582
St.dev.	0.110	0.092	0.094

The average efficiency of these industries increased each year from 0.767 in year 2003 to 0.897 in year 2007 at the rate of 4.02. This increment is in line with the estimated value of η (0.238), whose positive sign implies minimum efficiency increase over those years. However, based on the test statistics (which is 1.52), it is not significant at 5% and 10% significance levels (Table 16). This increase in efficiency supports the hypothesis that leather footwear industries have improved technical efficiency.

Table 16: Mean Technical Efficiencies in Leather Footwear Industries during 2003-2007

	2003	2004	2005	2006	2007	Average
Average effeciency	0.767	0.808	0.843	0.873	0.897	0.838
Growth rate in efficiency		5.375	4.361	3.516	2.822	4.018

5. Conclusions and policy implications

The availability of large livestock and labor resources in Ethiopia indicates the potential for the development of the leather sector. The leather sector significantly contributes to the manufacturing sector and its export earning 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 technical efficiencies of tanneries and leather footwear industries in the country over the period of 2003-2007. It 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.

A stochastic frontier model, developed by Battese and Coelli (1995), was used 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 tanneries had an average annual production growth rate of 24% over the period of 2003-2007. All of them were exporting their products, which on average comprises about 65% of their annual production. Industrial cost showed significant contribution to the production of tanneries as compared to other inputs. These industries used capital-intensive technologies utilizing 78% of their production capacity. There was large disparity among industries in production and in production capacity utilization.

The average technical efficiency for tanneries was 0.77 and there was an increasing trend over the considered period, as hypothesized in the study. The gamma value (0.90) shows that the inefficiency effect in total production substantially varies among the firms in the industry. This inefficiency results mainly from poor quality of raw hides and skin, obsolete machinery, lack of skilled labor and poor managerial skills. In addition, more value-adding tanneries had larger scale of operations, better export-orientation and were more technically efficient than the less value-adding ones, as hypothesized.

The leather footwear industries showed an average annual production growth rate of 12% with the utilization of only 57% of their production capacity. These 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, as hypothesized. The estimated gamma value of 0.26 indicates that the effect of external factors was much more than the internal technical efficiency effects in determining output variation among industries. These external factors include lack of better technology, financial resources and marketing skills. As hypothesized, exporting industries operated at a larger scale of production and better efficiency than the non-exporting industries, implying better orientation towards the international market.

In general, there exists a potential to increase output in the leather sector through improving efficiency of utilizing the existing resources as well as tackling external problems hindering the development of the sector. This includes improvement in the quality of raw materials, better production and marketing system. To improve the quality of raw hides and skin supply, the focus needs to start from improvement of animal husbandry system, through proper system of slaughtering, collection, storage and preservation of hides and skins along with infrastructural development. There needs to improve product quality with better design and technology, upgrade manpower and managerial skills. Efficient marketing skills with up-to-date market information and international exposure are also essential. Moreover, linkage with the global leather supply chain through sub-contracts, partnership and other alliances can have considerable effect in development of the sector.

In order to benefit from the comparative advantage of abundant livestock resources of the country and to achieve sustainable industrial growth, continuation of policy-based effective support of the government to the sector is imperative.

References

Ajibefun, A. Igbekele (2007). Technical Efficiency Analysis of Micro-enterprises: Theoretical and Methodological Approach of the Stochastic Frontier Production Functions Applied to Nigerian Data. *Data Journal of African Economies*, Federal University of Technology, Nigeria.

Aigner, D.J., C.A.K., Lovell, and P.J. Schemidt, (1977) "Formulation an Estimation of Stochastic frontier production models", Journal of Econometrics, Vol.6.

Battese G.E., and T.J. Coelli(1995) "A model for technical inefficiency Effects in a Stochastic frontier Production function for panel Data," Empirical Economics.

Carlton W. Dennis. and Perloff M. Jeffrey (2000). *Modern Industrial Organization.* Third edition: United States of America.

Cororaton B. Caesar et. al. (1995). "Estimation of total Factor Productivity of Philippine. Manufacturing Industries: the estimates" .discussion paper series No.95-32: Philippine.

Coelli T, D. S. Prasada Rao, G.E. Battese (1998). "An introduction to efficiency and Productivity Analysis ,"Kluwer Academic Publisher.

Daniel G.H. (2006). Measurement and Sources of Technical Efficiency in Ethiopian Manufacturing Industries, An MSc Thesis, Addis Ababa University , Unpublished.

Economic Development Institute of the World Bank (1993). "International Competitiveness: Interaction of Public and Private Sector", *Collected Papers from EDI policy seminar in Republic of Korea:* United States of America.

Ellis F.(1993). 'Peasant Economics: Farm Households and Agrarian Developments,' Cambridge University Press, Cambridge.

Ethiopian Export Promotion Agency (2000). Profile of the Ethiopian Leather Industry Sub-sector. Addis Ababa.

Ethiopian National Bank (2006/2007).*Annual report*. Addis Ababa.

Ethiopian Tanners, Footwear and Leather Garments Manufacturing Association (2004). *Leather Journal* Vol. 1, Issue No. 1.Addis Ababa.

Farrell, M. J., (1957).'The Measurement of Productive Efficiency, 'Journal of the Royal Statistical Society, Vol.120,Series A, part III.

Getnet Alemu and Admit Zerihun (2001). The Ethiopian Manufacturing Sector: Competitiveness and the Way Ahead, *Journal of Economics*, Vol. X No.2. Addis Ababa.

Getu Alemu (2005). 'Technical Efficiency of Small Holder Cereal Production in Ethiopia. A Stochastic Frontier Analysis using Panel Data from Selected. Villages", Thesis, Economics Department, Addis Ababa University, Unpublished.

Jemal Hassen (2008). "Measuring Total Factor Productivity and Competitiveness of Ethiopian Textile and Garment Industries", An MSc Thesis, Economics Department, Addis Ababa University, Unpublished.

Maddala, G. S., (1992) "Introduction to Econometrics" New York :McGraw-Hill Book Company.

Ministry of Finance and Economic Development(2006). "Macro Economic Development in Ethiopia report". Addis Ababa.

Ministry of Trade and Industry (MOTI) (2008). *Export Trade Journal*, Special issue. Addis Ababa.

Ministry of Trade and Industry, Textile and Leather Industry Development Centre (2000)."Action Plan to Support Leather and Textile Sector Export for the year 2006/2007".Addis Ababa.

Textile and Leather Industry Development Centre (2008)." Report on Ethiopian Tanneries Production Capacity Building". Addis Ababa.

UNIDO (2002). A Blueprint for the African Leather Industry: A Development, Investment and Trade Guide or the Leather Industry in Africa. Addis Ababa.

UNIDO (2005). Master plan; A Strategic Plan for the Ethiopian Leather and Leather Products Industry. Addis Ababa.

USAID (2005). Export Competitiveness Study of the Dominican Footwear Industry.

Walujadi, Dedi (2004). 'Age, Export Orientation and Technical Efficiency Evidence from Garment Firms in Dkijakarta' *Journal of Bina Nusantara University.* Jakarta

Worku Gebeyehu (2001). Is the Ethiopian Leather Industry on the Right Track? An Empirical Investigation, *Journal of Economics*, Vol. X No.2. Addis Ababa.

World Bank(1993). Organization for Economic Co-Operation and Development: Glossary of Industrial organization Economics and Competition Law.

World Bank (2007). "Competition Policy and Promotion of Investment, Economic Growth and Poverty Alleviation in Least Developed Country".

Zalina Zahid and Marziah Mokhtar,(2007). "Estimating Technical Efficiency of Malaysian Manufacturing Small and Medium Enterprises: A Stochastic Frontier Modelling", University Teknologi Mara Shah Alam, Malaysia

Appendix 1: Technical Efficiencies of Tanneries during 2003-2007

	2003	2004	2005	2006	2007	average
	0.8583	0.8584	0.8585	0.8586	0.8587	**0.8585**
	0.6046	0.6048	0.6050	0.6052	0.6054	**0.6050**
	0.9267	0.9268	0.9268	0.9269	0.9269	**0.9268**
	0.7666	0.7667	0.7668	0.7670	0.7671	**0.7668**
	0.7835	0.7836	0.7837	0.7839	0.7840	**0.7837**
	0.7651	0.7652	0.7654	0.7655	0.7657	**0.7654**
	0.9207	0.9207	0.9208	0.9208	0.9209	**0.9208**
	0.7717	0.7718	0.7719	0.7721	0.7722	**0.7719**
	0.3337	0.3340	0.3342	0.3345	0.3347	**0.3342**
	0.7843	0.7844	0.7846	0.7847	0.7848	**0.7846**
	0.9206	0.9207	0.9207	0.9208	0.9208	**0.9207**
Average	0.7669	0.7670	0.7671	0.7673	0.7674	**0.7671**
Max	0.9267	0.9268	0.9268	0.9269	0.9269	**0.9268**
Min	0.3337	0.3340	0.3342	0.3345	0.3347	**0.3342**
St.dev.	0.1720	0.1719	0.1719	0.1718	0.1717	**0.1719**

Appendix 2: Technical Efficiencies of Leather Footwear Industries during 2003-2007

	2003	2004	2005	2006	2007	average
1	0.8633	0.8897	0.9115	0.9292	0.9436	0.9075
2	0.8615	0.8883	0.9103	0.9282	0.9428	0.9062
3	0.6928	0.7471	0.7936	0.8327	0.8652	0.7863
4	0.8666	0.8925	0.9137	0.9310	0.9450	0.9098
5	0.6771	0.7337	0.7823	0.8234	0,8575	0.7748
6	0.7210	0.7711	0.8137	0.8493	0.8788	0.8068
7	0.6028	0.6694	0,7277	0.7777	0.8198	0.7195
8	0.8631	0.8896	0.9114	0.9291	0.9435	0.9074
9	0.6440	0.7053	0.7583	0.8033	0.8410	0.7504
10	0.8631	0.8896	0.9114	0.9291	0.9435	0.9073
11	0.8237	0.8571	0.8848	0.9076	0.9261	0.8799
12	0.8343	0.8659	0.8920	0.9134	0.9309	0.8873
13	0.6044	0.6707	0.7289	0.7786	0.8206	0.7206
14	0.9058	0.9244	0.9396	0.9519	0.9618	0.9367
15	0.8680	0.8936	0.9146	0.9317	0.9456	0.9107
16	0.8929	0.9140	0.9312	0.9451	0.9563	0.9279
17	0.8653	0.8914	0.9128	0.9303	0.9444	0.9089
18	0.8579	0.8853	0.9079	0.9263	0.9412	0.9038
19	0.8501	0.8789	0.9027	0.9221	0.9378	0.8983
20	0.8864	0.9087	0.9269	0.9416	0.9535	0.9234
21	0.6526	0.7127	0.7646	0.8086	0.8454	0.7568
22	0.6693	0.7270	0.7767	0.8187	0.8536	0.7690
23	0.9152	0.9321	0.9459	0.9569	0.9658	0.9432
24	0.7533	0.7983	0.8364	0.8680	0.8940	0.8300
25	0.5101	0.5868	0.6560	0.7166	0.7686	0.6476
26	0.7605	0.8044	0.8414	0.8721	0.8974	0.8352
27	0.7327	0.7810	0.8219	0.8561	0.8843	0.8152
28	0.4301	0.5130	0.5900	0.6592	0.7197	0.5824
Average	**0.7667**	**0.8079**	**0.8431**	**0.,8728**	**0.8974**	**0.8376**
Max	**0.9152**	**0.9321**	**0.9459**	**0.9569**	**0.9658**	**0.9432**
Min	**0.4301**	**0.5130**	**0.5900**	**0.6592**	**0.7197**	**0.5824**
St.dev.	**0.1289**	**0.1100**	**0.0924**	**0.0767**	**0.0630**	**0.0942**

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 duly acknowledged.

Name:- Genet Zenebe Mekuria

Signature:________________

Confirmed by Advisor Dr. Hussien Hamda

Signature:-________________