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**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES**



**THE IMPACT OF PRIVATIZATION ON TECHNICAL
EFFICIENCY OF LARGE AND MEDIUM SCALE
MANUFACTURING INDUSTRIES:
A FIRM LEVEL ANALYSIS**

REBEKA KEBEDE HAGOS

JUNE 2001

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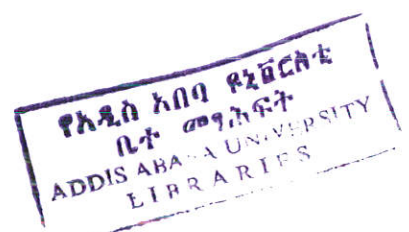
**A Thesis Presented to the School of Graduate studies
Addis Ababa University in Partial Fulfillment of
the Requirements for the Degree of
Master of Science in Economics**

By

Rebeka Kebede Hagos

June 2001

Addis Ababa



Addis Ababa University
School of Graduate Studies

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MANUFACTURING INDUSTRIES: A FIRM LEVEL ANALYSIS**

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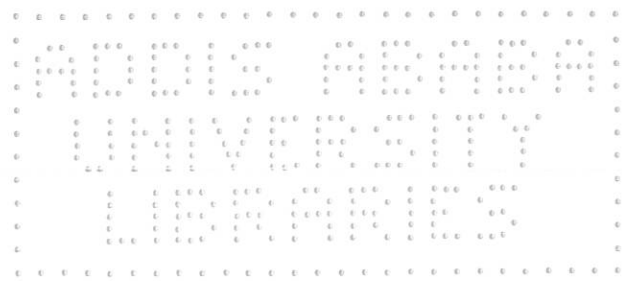
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ABSTRACT

In the 1980's and 1990's instead of government controlled centralized planning, there has been a renewed emphasis on market oriented strategy. Privatization is one of the parts of this strategy. One of the objectives of privatization is to increase efficiency through ownership change. In the theory of privatization it is believed that ownership matters i.e. the transfer of property right from the public to the private sector will give incentive to increase efficiency. In 1950's and 1960's private ownership was dominant in Ethiopia, then in 1970's and 1980's large and medium scale manufacturing industries were nationalized. In 1990's Ethiopia undertook a reform program, privatization being one of the parts of this program. Studying the impact of privatization is important for policy makers in analyzing post-privatization consequences and derive policy in future privatization process. In this study a panel data for 25 privatized large and medium scale manufacturing industries covering a period of seven years (1992/93-1998/99) is taken and a test whether there is technical efficiency (TE) gain due to privatization is examined by using stochastic frontier model. The analysis is made in five sectors and first a test whether there exist some kind of inefficiency among firms is made. The result showed that there exist inefficiency among all firms. The second test is made to identify the appropriate model. The impact of privatization on TE is then analyzed and it is found that for food processing sector, there has been a positive effect of privatization in improving TE where as for beverage and textile and leather sectors there has been a negative effect of privatization in improving TE. For non-metal and wood and printing and chemical sectors it is found that there is no significant impact of privatization in TE improvement. The results suggest that for sectors with competitive behavior there has been a positive effect of privatization in TE while for sectors with semi-monopolistic behavior there has been a negative effect of privatization on TE improvement. It is also found that sectors that under took new capital investment due to new capital investment criteria set by Ethiopian Privatization Agency(EPA) showed a negative effect of privatization on TE. This suggests that there is a need to establish anti-trust laws, adjust some policy -related constraints that could discourage new entrants and address post-privatization issues in the future privatization process.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Ownership is a core and controversial element in all societies. Some nations give more emphasis to state ownership while others give more emphasis to private ownership. During the 1960s and 1970s state ownership and the expansion of public sector in size and scope has been significant in many LDCs. However during the 1980s and 1990s instead of government controlled centralized planning, market oriented strategy became a new strategy.

In developing economies policies of substantial liberalization, privatization and market orientation have been strongly recommended by organizations like IMF and World Bank. These proponents of privatization argue that the financial record of public enterprises World-wide is in itself evidence for the necessity of privatization.

In the case of Sub-Saharan African countries, the contribution of state owned enterprises (SOEs) to total out put is on average 17.3 percent in 1991 (World Bank policy research report ,1995 : 268). Public enterprises' financial losses as a percentage of GDP for some African countries are

more than five (5) percent (Osma, 1997:65). These losses are due to constraints imposed by their governments on pricing decision, investment policies, and other factors like employment policies.

Privatization policy is mainly introduced as a measure of achieving efficiency based on the assumption that state-owned enterprises do not operate in a cost-minimizing manner. UNDP in 1993 estimated the losses of public enterprises in a number of countries and regions and showed that the argument for privatization of state owned enterprises lies on two points (Osma,1997).

The first point is the belief in private sector technical and allocative efficiency superiority irrespective of institutional factors. The second point is the social opportunity cost of public enterprises losses i.e. if the amount of losses by public enterprises does not occur, the money used by the government to cover the losses could have been spent on other sectors such as health and education.

Successful development of the industrial sector plays a key role in the long run economic and social progress of a given country. Ethiopia is known for long tradition in the development of handicraft and cottage industries. The introduction of modern large and medium scale manufacturing is a 20th-century phenomenon. In 1925, there were 25 factories in major urban centers and 22 of them were established by private owners. A number of manufacturing industries came into existence between 1941 and 1955 (MEDaC, 1999).

Import substituting manufacturing establishments were largely owned by foreigners and their number was 273 prior to the 1974 revolution. The role of the government at that time was relatively small with full ownership of only 13 manufacturing establishments. The majority of

manufacturing plants, especially large and medium scale establishments, were owned by foreigners and heavily protected from external competition.

The military regime, which came to power in 1974, nationalized all private large and medium scale manufacturing establishments in 1975. At that time the military government emphasized on the development of large and medium scale manufacturing through favoring government owned enterprises in allocation of resources like foreign exchange, labor and credit.

Public enterprises were also granted market monopoly for their output and the quality and level of production and price were determined by central planning. This eliminated business incentive and mechanism to improve the mix and quality of production. The radical change in the structure of ownership severely curtailed private initiative in large and medium scale manufacturing. Policies at that time limited the ceiling on private sector investment capital to Birr 500,000 (MEDaC, 1999)

After the fall of the military government in 1991, Transitional Government of Ethiopia took decisive reform measures which encourage the active participation of the private sector and the government took privatization as a means to achieve this objective

During the time of privatization there were 121 public manufacturing enterprises. Out of these, 106 were planned to be privatized. From 1995 to 1998 out of the planned 45 manufacturing public enterprises, 24 were privatized. The total amount of revenue generated out of the sale of this enterprises is 872.1 million Birr, which is 31% of the total revenue generated through over all privatization in the country until 1998 (MEDaC, 2000).

Privatization in Ethiopia is a recent phenomenon. After the economic reform that took place in 1991/92, the participation of the private sector in large and medium scale manufacturing production has increased. One of the factors that has increased the contribution of the private sector was privatization policy. The main arguments of privatizing large and medium scale manufacturing industries are efficiency gain due to ownership change and revenue generation objective that could be achieved through sale of state owned enterprises and by collecting tax.

The revenue generation objective of privatization can be easily seen from the amount money collected by sale of enterprises. A study that looks into the impact of economic reform of public enterprises has been done by Taye (1994). However the comparison was made in major industrial group and the impact of the reform period on efficiency gain of these enterprises was not made.

Even though the period over which privatization policy has been implemented is not so long, there is a need to examine whether privatization of large and medium scale manufacturing has achieved its objective of facilitating economic development through technical efficiency gain. The purpose of this study is to analyze the impact of privatization of large and medium scale manufacturing industries on technical efficiency.

The paper is organized as follows, chapter two is an overview of Ethiopian economy, large and medium scale manufacturing industry and privatization in Ethiopia. Chapter three is literature review where both theoretical and empirical literatures are reviewed. In chapter four, methodology and data sources are discussed. Chapter five covers estimation and analysis of results. Finally, under chapter six, conclusion and policy recommendation are made.

1.2 OBJECTIVES OF THE STUDY

The general objective of the study is to examine whether privatization of large and medium scale manufacturing enterprises has brought some gain in technical efficiency or not.

Specific objectives of the study are:

- To measure technical efficiency of privatized large and medium scale manufacturing firms.
- To measure technical efficiency of public large and medium scale manufacturing firms before privatization.
- To examine whether ownership change has significant effect on technical efficiency and whether there is a technical efficiency gain due to privatization.

1.3 HYPOTHESES OF THE STUDY

Based on the specific objectives of the study, the hypotheses of the study are set as follows:

- There is a significant difference in technical efficiency between private and public large and medium scale manufacturing firms.
- Privatization has a significantly positive effect on technical efficiency gain in Ethiopia.

1.4 SIGNIFICANCE AND SCOPE OF THE STUDY

This study will be useful for policy makers to examine the impact of privatization on economic development and to check whether economic development goal of privatization is achieved or not. By doing so it helps policy makers to conceive appropriate policy in the future privatization process. In this study, large and medium scale manufacturing industries that have been privatized during 1992/93 to 1998/99 will be covered and technical efficiency of each firm during the period will be estimated.

1.5 LIMITATION OF THE STUDY

Since privatization is a recent phenomenon, the analysis will be limited to a short period of time. The number of establishments available for the analysis is not very large.

CHAPTER TWO

LARGE AND MEDIUM SCALE MANUFACTURING AND PRIVATIZATION IN ETHIOPIA

Before we go to the details of large and medium scale manufacturing and privatization in Ethiopia, it is necessary to look at an overview of the Ethiopian economy which is presented in the following section.

2.1 AN OVERVIEW OF THE ETHIOPIAN ECONOMY

Ethiopia, with a population of about 54 million in 1994, is the second most populous country in Sub-Saharan Africa. Population growth was about 2 per cent in 1950 and it has increased to 2.9 percent per annum in 1984. The average population growth rate is expected to be 2.46 percent per annum between the period 1995-2030 (CSA, 1996).

The Ethiopian economy is largely based on agriculture, which on average accounted for 50 percent of gross domestic product (GDP), 85 percent of total employment, 90 percent of export earnings and 70 per cent raw material supply for agro-based large and medium scale industries. Crop production contributes 60 per cent of value added, where as livestock and forestry and other sub-sectors contribute 27 and 13 per cent respectively (MEDAC, 2000).

Ethiopia is well endowed with natural resources like gold, platinum, marble, tantalite,

copper, potash, soda ash, zinc, nickel and iron. Large amount of gas reserve exist in the eastern region. Despite the promising vast reserves, the development of mining industry has been slow.

Average value added growth rate for mining and quarrying was 6.4 per cent per annum during 1980/81 to 1989/90 and it has increased to 25.1 per cent per annum for the period 1990/91 to 1998/1999 (MEDAC, 2000).

Although Ethiopia has huge hydropower potential, only 1 per cent of the existing potential is being utilized and Less than 5 per cent of the total population gets electricity service. The total installed capacity since 1988 is 418.8 MW. Out of this, 10 percent has not been realized because the equipment is out dated and there was maintenance problem. Electricity generation has increased on average by about 6.7 per cent per annum during 1991/92 to 1997/98 (MEDAC, 1999).

The Ethiopian domestic water supply coverage is very low compared to Sub-Saharan Africa countries. Out of the total population only 26 per cent gets domestic water supply where as only 7 per cent get sanitation service. Average value added growth rate for electricity and water was 4.7 per cent per annum during 1980/81 to 1989/90 and it has decreased 3.4 per cent per annum for the period 1990/91 to 1998/1999 (MEDAC, 1999).

Health sector indicators of Ethiopia are low compared to Sub-Saharan African countries. In 1993, infant mortality was 103 per 1000 live birth and maternal mortality rate was estimated

to be 5 to 6 per 1000 live births in 1995 (MEDAC, 1999).

Average value added growth rate for health sector was 4.1 per cent per annum during 1980/81 to 1989/90 and it has increased to 8.1 per cent per annum for the period 1990/91 to 1998/1999.

The Ethiopian education system has changed three times. During the imperial regime the school structure was 4 years of elementary, 4 years of jounior secondary and 4 years of senior secondary and during Derg regime it became 6 years of elementary 2 years of jounior secondary and 4 years of senior secondary. Currently the education system is 8 years of primary, 2 years of general secondary and 2 years of preparatory senior secondary school.

Average value added growth rate for education sector was 2.8 per cent per annum during 1980/81 to 1989/90 and it has increased to 3.7 per cent per annum for the period 1990/91 to 1998/1999 (MEDAC,1999).

Despite the rapidly growing and predominantly young population of Ethiopia, the available job opportunity is very low. According to 1999 labor force survey conducted by C.S.A, unemployment rate at national level stood to 8.06 per cent per annum, and for urban and rural area unemployment rate was estimated to be 25.7 and 5.14 per cent per annum respectively.

Historically, Ethiopia has been a low inflation country. This is partly explained by its prudent fiscal policy, income and price policy, the degree of monetization of the economy

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Historically, Ethiopia has been a low inflation country. This is partly explained by its prudent fiscal policy, income and price policy, the degree of monetization of the economy

and low level of economic development. In 1980's the maximum inflation rate was 18.5 per cent during drought year of 1984/85. In the first two fiscal year of the 1990's inflation was 21 per cent because of social and economic crises that resulted from civil war. The inflation rate then declined and it became 2.3 percent in 1997/98 (MEDAC, 1999).

The external sector in Ethiopia in the 1980's has been weak and during this period export earning averaged about 400 million USD per annum which is on average only 6 per cent of GDP. The largest share of export earning of Ethiopia comes from agricultural product. Imports on the other hand grew at an average rate of 7 per cent per annum and its share of GDP was about 15-12 per cent.

Export earning has increased from 154.2 million USD in 1991/92 to 600 million USD in 1996/97. (The comparison is made between peak and slack periods) The share of export earning of the private sector has also increased from 15 per cent in 1990/91 to 80 per cent in 1997/98 (MEDaC, 1999).

Import has also shown significant increase. Merchandise import was 875.8 million USD in 1991/92 and it has increased to 1.45 billion USD in 1997/98.

The reserve position has been 3 weeks of import in 1991/92 and it has improved to 33.1 weeks of import in 1995/96, 22.6 weeks of import in 1996/97, and 15 weeks of import in 1997/98 (MEDAC, 1999). This fluctuation of reserve position is because its dependency on external resource.

During 1980/81 to 1989/90 there was a significant increase both in total government

revenue and expenditure. The annual growth in expenditure was 8 per cent on average where as the annual growth in revenue was 6.4 per cent on average and this made worsening budget deficit during that period. By 1989/90 total government expenditure stood at 5369.2 million Birr and revenue at 3142.8 million Birr.

Domestic revenue annual average growth rate has been 22 per cent during 1991/92 to 1997/98 and absolute terms it has increased from Birr 2.2 billion in 1991/92 to 84 billion in 1997/98. Fiscal deficit excluding grant has declined from 11 per cent in 1991/92 to 5 per cent of GDP in 1996/97. Government borrowing from domestic bank source decline and large amount of deficit is financed from external source since 1995/96 (MEDAC,1999).

During 1980/81 to 1989/90, large size of deficit financing was the major source of monetary expansion and growth of money supply has been faster than the nominal value of goods and services in the economy. The average growth rate of broad money (M_2) during this period has been estimated to be 11.6 per cent per annum. During 1991/92 to 1997/98, average growth rate of broad money (M_2) has been estimated to be 12 per cent per annum(MEDAC, 1999).

Since the declaration of new economic policy in 1991, a number of macro and micro economic reforms have been implemented. These includes:

- The foreign exchange regimes were rationalized by devaluation of Birr and the privilege given to SOEs in the allocation of foreign exchange have been abolished.
- A new investment law has been set to encourage the participation of both domestic and

foreign investors.

- State corporations which were responsible for managing public enterprises have been dissolved and public enterprises were reconstituted as autonomous entities with legal entities with legal personalities. They have been managed by board directors. The management of each public enterprises is free to set prices, production plan and marketing strategy.
- The interest rate has been revised to reflect the value of investment and uniform interest rate has been set for both public and private.
- Taxation system has been improved to harmonize the difference between the private and public sectors.

2.2 LARGE AND MEDIUM SCALE MANUFACTURING

2.2.1 INTRODUCTION

Manufacturing is defined according to International Standard Industrial Classification (ISIC) as the physical or chemical transformation of material or components into new products, whether the work is performed by power driven machine, or by hand, whether it is done in a factory or in workers home and whether the products are sold at whole sale or retail. The assembly of the component part of manufactured product is also considered as manufacturing activity.

Large and medium scale manufacturing in this study is confined to those establishments which engage 10 persons and above and use power-driven machines . According to the 1998/99 survey

of large and medium scale manufacturing conducted by CSA , the total number of large and medium scale manufacturing industries at national level was 779 .

The Ethiopian large and medium scale manufacturing industry is mainly characterized by high concentration of food and beverage manufacturing industrial group. Out of the 779 manufacturing industries those that manufacture food and beverage constitute the largest number which is 29.27 percent of the total. The second is manufacture of furniture which is 15.53 percent of the total and the third is manufacture of other non-metallic minerals which is 11.3 percent of the total number.

2.2.2 DISTRIBUTION OF LARGE AND MEDIUM SCALE MANUFACTURING INDUSTRIES (LMS) AMONG REGIONS.

The distribution of large and medium scale manufacturing industries among regional states shows some skewness for the period 1992/93 to 1998/99. Among the regions of the country region 14 contributed 63.67 percent of the total establishments. The second region is Oromiya while the third is S.N.N.P (CSA, 20001). The average distribution of LMS among regions for the period 1992/93 to 98/99 is presented in the following table.

Table 2.1: Regional distribution of LMS in Ethiopia.

REGION	NUMBER OF ESTABLISHMENTS
TIGRAY	29
AFAR	4
AMAHARA	52
OROMYIA	105
SOMALE	-
S.N.N.P	57
GAMBELLA	2
ADDIS ABABA	496
DIRE DAWA	24
HARARI	10
TOTAL	779

Source: own computation

2.2.3 EMPLOYMENT IN LARGE AND MEDIUM SCALE MANUFACTURING

large and medium scale manufacturing sector covers 4.49 per cent of the total employment in the economy (CSA 1999). Employment in LMS has been concentrated in textile, food, beverage and chemical industrial group which accounted for 78 percent of the total employment in LMS for 1980/81 and 70 percent for 1995/96 and 1996/97. Out of the 70 percent , textile constituted 35 percent.

The growth of employment in LMS for the period 1980/81 to 1990/91 was 1.1 percent per annum and it has increased to 2.2 percent per annum for the period 1991/92 to 1996/97. Employment in LMS for the period 1991/92 to 1996/97 is presented in the following table.

Table 2.2: Number of Employees in the Large and Medium Scale Manufacturing Industries by Industrial Group 1991/92 - 1996/97 (1984 - 1989 EFY)

No.	Industrial Group	Fiscal Years														
		1991/92			1992/93			1993/94			1994/95			1995/96		
		Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public	Total
1	Food	1126	13552	14678	1106	13929	15035	1749	14768	16517	1793	13709	15502	2451	13297	15748
2	Beverage	140	7593	7733	154	7259	7413	121	7260	7381	136	7915	8051	183	7267	7450
3	Tobacco	-	938	928	-	984	984	-	993	993	-	987	987	-	982	982
4	Textile	340	33707	34047	350	33147	33494	805	33644	34449	1023	33880	34903	997	31444	32441
5	Leather & Shoe	530	5748	6278	494	5773	6267	1336	5853	7189	1091	5944	7035	1824	5924	7748
6	Wood & Furniture	532	4106	4638	559	3712	4271	1345	3478	4823	1436	3359	4795	1987	2783	4770
7	Paper-printing	373	4026	4399	367	4062	4429	437	4163	4600	788	4210	4998	1024	4526	5550
8	Chemical	186	3328	3514	190	3407	3597	713	3380	4093	1016	3669	4685	1155	3889	5044
9	Non-metal	207	2914	3121	214	3033	3236	537	4069	4606	641	4691	5332	1259	4779	6038
10	Metal	560	2748	3308	558	2795	3353	855	2736	3591	1008	2917	3925	1490	27778	4268
	Total	3994	78650	82644	3992	78090	82082	7898	80344	88242	8932	81281	90213	12370	77669	90039

.. cont. Table 2

No.	1996/97			Annual Average* Growth Rates (%)
	Private	Public	Total	
1.	3510	12725	16235	2.0
2.	2552	5043	7595	-0.4
3.	-	953	953	0.3
4.	1858	29939	31797	-1.4
5.	2128	6016	8144	5.3
6.	3513	1945	5458	3.3
7.	1303	3800	5103	3.0
8.	2259	3840	6099	11.6
9.	2009	4645	6654	16.3
10.	858	2751	4327	5.5
Total	20708	71657	92365	2.2

Source: Survey of Ethiopian economy, MEDaC, 1999.

- Growth rate is calculated by using compounding formula

2.2.4 GROSS VALUE OF OUTPUT (GVO)

Food, beverage, textile, leather and shoe and chemicals industrial groups are the major contributors to GVO¹ in large and medium scale manufacturing. In 1980 food, beverage, textile and chemicals contributed 78 percent of gross value of production. However, in 1990 the contribution of these groups declined to 70 percent and in 1995/96 it became 60 percent only.

The percentage share of GVO of the private sector has increased since reform period. In 1991/92, the contribution to GVO of privately owned manufacturing establishment was only 5.6 percent per annum which increased to 6 percent in 1992/93 and 9 percent in 1993/94. In 1994/95 and 1995/96 GVO contribution of privately owned manufacturing establishments to GVO in LMS was 13 percent and it has increased to 21 percent in 1996/97 (CSA , 1997:).

GVO was declining by 1.6 percent per annum for the period 1980/81 to 1990/91. Out of this 1.3 percent belonged to textile and 24 percent to chemical producing industrial group. This decline in GVO began to be reversed after the launching of economic reform program in 1991/92.

For the period 1991/92 to 1996/97 GVO has increased on average by 27.7 percent per annum. During the same period chemical, metal and non-metal production expanded by 42 and 45 percent respectively where as food, beverage, textile and printing and paper increased by 20 to 27 percent respectively. The least growth was seen in the manufacture of tobacco group which was about 10 percent.

This fast change in the percentage growth of GVO after reform program is because of the incentive given to each public manufacturing enterprises by giving managerial autonomy and financial responsibilities that has created profit maximizing incentive. The expansion of privately owned LMS and the increase in agricultural output that made supply of raw material available has also contributed for the increase in GVO of LMS.

2.2.5 VALUE ADDED

Value added at national account concept is calculated as the difference between GVO and intermediate input that include both industrial and non-industrial cost. Value added at factor cost is value added minus net indirect tax (indirect tax less subsidies).

Value added for LMS has been declining at 2.4 percent per annum for the period 1980/81 to 1990/91. This may be due to inefficiency of resource utilization in the public owned manufacturing enterprises . However for the period 1991/92 to 1996/97 value added at current factor cost has increased on average by 38 percent per annum.

Among industrial groups metal, non-metal, and leather and shoe value added has increased at 67, 62 and 54 percent respectively , where as value added in the food, wood and furniture, and chemical groups increased at 47, 34 and 40 percent per annum respectively. Value added of textile and tobacco groups increased only by 22 and 11 percent respectively (MEDAC, 1999).

Value added growth rate slowed down for the period 1945/95 to 1996/97 for some industrial

¹ GVO is quantity of goods produced multiplied by their respective price.

groups. This includes leather and shoe group where its growth rate became only 15 percent, metal group whose growth rate became 2 percent and textile group where its growth rate showed 7 percent annual decline.

If we compare annual growth rate of value added of public and private LMS, annual increase of private LMS was higher than public LMS. The percentage share of value added contribution of private LMS increased from 6 percent in 1991/92 to 19 percent in 1996/97.

If we look at value added contribution of each industrial group; about 60 percent of the value added was generated by food, beverage, leather and shoe, and textile groups in 1996-97, where as non-metal and chemical industrial groups contributed 11 and 9 percent for the same period respectively .

Value added per person had been declining at 3.4 percent in the period 1980/81 to 1990/91 . This decline in labor productivity was due to redundancy of labor. Labor productivity grew on average by 35 percent for the period 1991/92 to 1996/97.

Public LMS value added per person has increased faster than private LMS, this may be because public LMS had underutilized capacity than private LMS. Value added per person in absolute terms has increased from Birr 4 thousand in 1991/92 to Birr 19 thousand in 1996/97 in public sector and increased from Birr 5 thousand in 1991/92 to Birr 15.7 thousand in private sector (CSA , 2001).

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2.2.6 MANUFACTURING EXPORT

The contribution of LMS export in terms of foreign exchange earnings is about 15 percent. The export structure of LMS is such that food and leather and shoe products contribute about 90 percent of the total manufacturing export.

2.3 PRIVATIZATION IN ETHIOPIA

2.3.1 INTRODUCTION

Privatization policy has been implemented in Ethiopia since 1995. Accordingly privatization, is defined as the transfer, through sale of enterprise or its unit or asset or government share holdings in a share company to private ownership and this includes :

- a) The making of an enterprise a government contribution to a share company to be formed with the participation of private investors.
- b) Privatization of the management of an enterprise.(Negarit 1998).

The objectives of this privatization policy were:-

1. To promote the economic development of the country through encouraging the expansion of the private sector.

2. To generate revenue required for financing development activities undertaken by the government.
3. To change the role and participation of the Government in the economy to enable it exert more effort on activities requiring its attention.

Privatization agency planned to privatize 275 enterprises for the period 1992/93 to 1998/1999. Out of these 181 were privatized, for 4 enterprises the agreement was cancelled, 12 enterprises were closed, and 17 enterprises were transferred to their owners.

Hotel and restaurant ,household and office furniture and retail trade corporation were the first group to be privatized . In order to reduce the number of people that would become unemployed during this process , workers of the respective enterprises were given a share-holding chance and 1454 workers had become share holder. The development of privatization for the period 1992/93 to 1998/1999 is presented in the following table (MEDAC, 2000).

Table 2.3: The development of privatization during 1992/93-1998/99

SECTOR	PUBLIC ENTERPRISES	ENTERPRISES PUT FOR AUCTION	ENTERPRIS ES SOLD	TRANSFFERED TO THEIR OWNERS.	CLOSED	THAT WILL STAY PUBLIC
Retail trade	170	149	129	16	10	
Hotel and tourism	62	48	15	1		2
Industry	121	43	25	-		15
Agriculture	53	27	9	-	1	5
Construction	22	7	3	-		1
Transport	12			-		5
Mining	8	4	1	-		3
Banking & insurance	4	-	-	-		4
Other	4	-	-			
Total	456	275	181	17	12	36

Source: Private Sector Economy Performance Evaluation, MEDaC (2000).

2.3.3 SECTORAL PERFORMANCE OF PRIVATIZATION

WHOLESALE AND RETAIL TRADE

The total number of wholesale and retail trade enterprises under public ownership was 160 . Out of these 136 were privatized for the period 1992/93 to 1998/1999 and gross revenue generated amounted to 198.6 million Birr; which is 7 percent of the total revenue generated by privatization(MEDAC, 2000).

HOTEL RESTAURANT AND TOURISM

Privatization of hotel and restaurant was limited to small scale hotels and restaurants since there was no one to buy large scale hotel and restaurants (like Ethiopia hotel, Gion hotel and Wabiseble hotel) even though they were put for auction. For the period 1992/93 to 1998/99 15 small scale hotel and restaurants were privatized and the total revenue generated amounted 24.5 million Birr which is 7 percent of the total revenue generated by privatization(MEDAC, 2000).

INDUSTRY

The total number of publicly owned industries was 121 and out of this 106 industries were planned to be privatized by privatization agency. For the period 1992/93 to 1998/1999, 45 industries were put for auction and 25 of them were privatized. Their number was small because some auction were canceled, some of the industries are very far from Addis and investors were afraid of market inconvenience, and for some other industries like textile the available technology was outdated (MEDAC, 2000).

AGRICULTURE

The total number of publicly owned agricultural enterprises (agricultural enterprises include agro-industry, farm and livestock sub sector) was 53 out of which 48 were planned to be privatized. Twenty seven enterprises were put for auction and 9 of them were privatized. Revenue generated amounted to 45.4 million Birr, which is 14.8 percent of the total revenue generated by

privatization (MEDAC, 2000).

CONSTRUCTION

The total number of publicly owned construction enterprise was 22 and 21 of them were planned to be privatized. Out of this 7 enterprises were put for auction for the period 1992/93 to 1998/1999 and 3 enterprises were sold. The total revenue generated amounted to 53.7 million Birr (MEDAC, 2000).

MINING

The total number of publicly owned mining enterprises was 8 out of which 4 enterprises were planned to be privatized. Only one enterprise was privatized and the revenue generated was 172 million U.S dollars which is 44 percent of the total revenue generated by privatization.

For the period 1995 to 1999 the total revenue generated by privatizing public enterprises amounted to 2.82 billion Birr . Out of this 2.08 billion Birr, which is 74 percent was collected. Total revenue generated by the industrial sector is presented in the following table(MEDAC, 2000:).

Table 2.4 : Total revenue generated by industrial sector

SECTOR	NUMBER	REVENUE COLLECTED
RETAIL TRADE	129	200143880.9
HOTEL & RESTURANT	15	21322170.28
INDUSTRY	25	865855059.1
AGRO-INDUSTRY	6	74667910.28
AGRICULTURE	3	90283229.6
CONSTRUCTION	3	46729856.8
MINING	1	786002050

Source: own computation

CHAPTER THREE

LITERATURE REVIEW

3.1 THEORETICAL REVIEW

3.1.1 TECHNICAL EFFICIENCY

3.1.1.1 DEFINITION

Technical efficiency [TE] is the ability of a firm to produce maximum output from a given level of input. Technical efficiency is an important issue in the world of scarcity. In the introduction of his seminal paper, Farrell (1957) noted that ‘ if economic planning is to concern itself with particular industries, it is important to know how far a given industry can be expected to increase its output by simply increasing its efficiency, without absorbing further resources.’

At a given production technology, a firm is said to be technically efficient if it produces on its outer bond production function in order to obtain the maximum possible output. In other words a firm is technically efficient if it operates at the point on the iso-quant rather than interior to the iso-quant. Technical efficiency of a firm can be calculated as the ratio of actual output to maximum obtainable output.

3.1.1.2 THE IMPORANCE OF TECHNICAL EFFICIENCY

Improving the level of output without using additional inputs or adopting better and new technology is an important issue for developing countries like Ethiopia , where resources are scarce and improving the available technology is difficult .The importance of measuring and analyzing the level of efficiency is expressed by Farrel (1957) as:

“ The problem of measuring productive efficiency of an industry is important to both the economic theorists and economic policy makers. If the theoretical arguments as to the relative efficiency of different economic systems are to be subjected to empirical testing, it is essential to be able to make some actual measurements of efficiency. Equally if economic planning is to concern itself with particular industries, it is important to know how far a given industry can be expected to increase its output by simply increasing its efficiency without absorbing further resources”

Efficiency is one of the most important issues in a developing economy since resources are scarce and improving the available technology is difficult for a developing economy. Increasing efficiency has policy implications both at macro and micro level . At the micro level if a certain firm increases its efficiency, it increases its productivity and profitability. At the macro level , increasing efficiency is one of the most important sources of growth.

Productive or technical efficiency analysis will help policy makers to formulate and evaluate policies like privatization policy, pricing policy, credit and raw material distribution policy .

Generally, there are four methodologies that can be used to examine production efficiency. These are linear programming method, average factor productivity method, profit function method and production function method. Out of these methods, production function approach is most widely used because, average productivity method is a method that does not take into account other factors which affect average or marginal productivity of firms and considers only one input at a time.

Linear programming approach uses a linear programming technique which does not use any algebraic form for the frontier. Profit function approach is a method that assume profit maximizing behavior.

Under Production function approach, there are two possible methods of estimating production function. These are production frontier model and average production model. Average production model is estimated by least square estimates and it assumes that the error term is randomly distributed with zero mean . This implies that information on efficiency can not be obtained since the model attribute the difference between the estimated and the actual function to symmetric random disturbance.

Due to this fact attempts to measure efficiency have been made by different scholars and frontier production model is found to be consistent with the definition of production function and for measuring production efficiency.

Attempts to estimate frontier production function began with the works of Farrel (1957). Subsequently , Aigner and Chu (1968) and Richmond (1974) estimated frontier production

function by using linear and quadratic programming technique (Mark 1980) . However this model does not allow for random shock outside the control of the firm and it considers any deviation from the frontier as technical inefficiency. In order to eliminate this problem , Timmer (1971) , separated the random shock from the inefficiency effects. Battese and Ceolli (1992) developed a stochastic frontier model.

The advantage of frontier production function approach is that it is conceptually close to the definition of production function which relates the maximum output attainable from a given level of inputs.

3.1.1.3 FRONTIER APPROACH TO MEASURING TECHNICAL EFFICIENCY

Different scholars have estimated frontier production function and the method used for its estimation is a combination of the following:

1. The way frontier is specified : The frontier can be specified as parametric or non-parametric.

Parametric frontier method is widely used and it assumes an explicit functional form for a given technology and frontier is expressed in mathematical form.

The advantage of parametric frontier approach is that it characterizes frontier production function in mathematical form and also it accommodates non constant return to scale

Non parametric frontier model are those that do not express frontier in mathematical form

and efficiency is estimated from the sample observation. It assumes no functional form to the data and no assumption about inefficiency is made and no standard error is estimated; and this makes it advantageous. The disadvantage of non parametric frontier method is that the estimated production frontier do not have any statistical properties that would make it sensitive to measurement error and outlier.

2) The way frontier is computed: The frontier can be computed by programming technique or by using explicit statistical procedure.

If frontier is computed by programming technique , it is not possible to make assumption about regressors or the disturbance term and the model will not have any statistical properties. Where as if it follows statistical procedure, the model will have statistical properties.

3) The way the deviation from frontier are interpreted : The deviation from the frontier may be simply considered as inefficiency (the model is deterministic) or it could be considered as a mixture of inefficiency and statistical noise (the model is stochastic). In stochastic model error due to statistical noise is not considered as inefficiency and this makes it advantageous over deterministic model.

By combining the above points, three dominant frontier approaches in measuring technical efficiency are identified. These are non-parametric data envelopment analysis (DEA), deterministic parametric frontier analysis (DFA) and stochastic frontier analysis (SFA) and they are presented in the following section.

3.1.1.4 Data Envelopment Analysis (DEA)

DEA is a linear programming approach which does not use any algebraic form for the frontier (i.e. it is non-parametric) and it also does not assume an inefficiency distribution (i.e. it is deterministic) Hjalmarsson et.al . In DEA the efficiency of a micro unit, m is measured relative to the efficiency of all the other micro units subject to the restriction that all-micro units ($I=1,2,...,m$) are on or below the frontier. Efficiency measure is achieved by restricting the reference point on the unknown frontier and using the same amount of input (s) as observed for the unit m .

The efficiency scores are obtained by solving the following linear programming (LP) problem for each unit i , with single output Y_i and input X_i ($X_i = X_{i1}, \dots, X_{ni}$) under variable return to scale (VRS),

$$\text{Max } \theta \dots\dots\dots(1)$$

$$\lambda, \theta$$

subject to

$$X, \lambda \leq X_k$$

$$\theta Y_k \leq Y\lambda$$

$$0 \leq \lambda, \theta$$

Where, X is an n by N input matrix with columns X_i ;

Y is an m by N output matrix with columns Y_i ;

λ is an N by one vector of weights to be attached to the sample firms for construction of an

efficient firm;

k denotes the decision-making unit (DMU) under investigation;

$I=1, \dots, N$ indexes DMUs;

N is the number of outputs; and

θ represents the output-oriented measure of technical efficiency.

Solving (1) amounts to maximizing the efficiency of the unit k subject to the efficiencies of all units in the set having an upper bound of one. By introducing restrictions on the sum of intensity weights (λ), DEA can accommodate different varieties of returns to scale.

3.1.1.5 DETERMINISTIC PARAMETRIC FRONTIER (DPF)

The basic concept of deterministic parametric frontier approach is that the parameters of the chosen function are such that the frontier of the estimated function lies on or above the observation (Hjalmarsson et.al) and it does not take into account random external shock, measurement error, omitted variable and noise in the data separately and it considers them as inefficiency.

Aigner and Chu (1986) constructed a homogeneous Cobb-Douglas production function and applied a quadratic programming technique to estimate deterministic parametric frontier production function. The model is given as:

$$Y_i = f(X_i; B_j) \exp(-u) \quad i=1, 2, \dots, n$$

Where

Y_i = Possible output level for i^{th} firm.

X_i = A vector of input for i^{th} firm.

U_i = Inefficiency effects for i^{th} firm ($0 \leq u_i$).

B_j = A parameter to be estimated.

$F(X_i; B_j)$ = A functional form.

$\exp(-u)$ lies between zero and one and this brings the relation $Y_i \leq f(X_i; B_j)$ which implies that the possible output is bounded from above by deterministic frontier production function. B_j s are estimated by linear quadratic programming technique and this does not assume any statistical distribution for efficiency and therefore the statistical property of the resulting estimate are unknown.

Deterministic frontier is extremely sensitive to outliers. In order to avoid this problem Aigner and Chu (1986) developed probabilistic frontier production function. The method under probabilistic frontier production function allows a small proportion of the observation to exceed the frontier and these outlier observations are discarded from the analysis. This method has problem of selection of proportion of observations and also it contradicts with the concept of frontier as maximum possible output.

3.1.1.6 Stochastic Frontier Analysis , SFA

Under SFA the deviation from the frontier is divided into two sources, statistical error and deviation due to technical inefficiency. There are three categories of SFA, these are, SFA1, SFA2 and SFA3 .

Model 1 (SFA1)

SFA1 is a regular panel data model with time varying technical inefficiency suggested by Battese and Coelli (1992). The stochastic production frontier model is specified as :

$$Y_{it} = f(X_{it}; \beta) + e_{it}$$

Where Y_{it} = Output of the firm I ($i=1,2,\dots,N$) at time t ($t= 1,2,\dots,N$)

$f(.)$ = The production technology.

X_{it} = A vector of n inputs .

β = Vector of unknown parameters to be estimated.

The error term is specified as $e_{it} = v_{it} - u_{it}$ where v_{it} is statistical noise and u_{it} is technical inefficiency.

The production technology is represented by the function

$$Y_{it} = \beta_0 + \sum \beta_j x_{jit} + \beta_t t + e_{it}$$

Where Y_{it} and X_j ($j= 1, \dots, n$) are the respective output and inputs measured in logarithms .

The time trend, t , captures exogenous technical change, which can be viewed as a shift in the

production frontier overtime . Technical change (E_t) is calculated from :

$$E_t = \partial_y / \partial t = \beta_t + \beta_{tt} + \sum \beta_{jt} x_j$$

In this model technical efficiency is specified as (Battese and Coelli 1992)

$$U_{it} = \exp[-\eta (t-T_i)] u_i = \eta_{it} u_i$$

Where η is a single unknown parameter and u_i is assumed to be normally distributed $N(\mu, \delta_u^2)$ truncated at zero from below. The noise component, v , is assumed to be i.i.d. $N(0, \delta_v^2)$.

Model 2 (SFA 2)

This model is an extension of the above model with the inclusion of some firm and production characteristic, z , as a control variable in the production function. Technical inefficiency is assumed to be independent of these z variables. The estimation parameters and prediction of technical efficiency are the same as SFA1.

Model 3 (SFA 3)

This model is an extension of SFA1 model with the inclusion of some firm and production characteristics, z as determinant of technical efficiency (Battese and Coelli 1995).

Technical efficiency model is specified as ;

$$U_{it} = \sum \delta z_{it} + w_{it}, u_{it} \geq 0$$

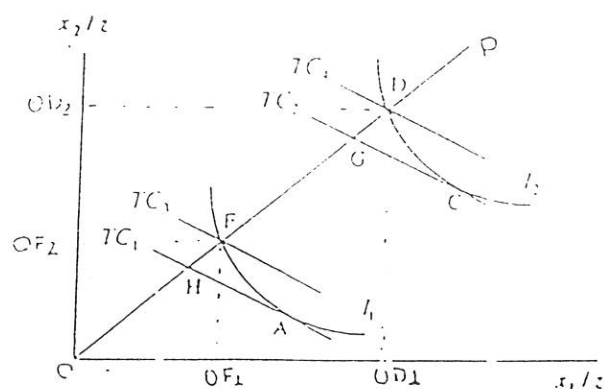
Following Battese and Coellie (1995), w_{it} i.i.d $N(0, \delta_u^2)$ truncated at $-\Sigma \delta z_{it}$ from below

The choice between different approaches of measuring technical efficiency depends on the purpose of the study, type of data available, technology characteristics etc.

3.1.1.7 TECHNICAL AND ALLOCATIVE EFFICIENCY : COMPARISON

Allocative efficiency [AE] is defined as the ability of a firm to maximize profit by equating marginal revenue product of inputs to their respective marginal costs. The combination of allocative efficiency and technical efficiency gives economic efficiency. Even though the study looks into technical efficiency, there is a need to note the difference between allocative and technical efficiency. In his classic article M.J Farrell distinguishes between two measures of production efficiency – technical and allocative (price) efficiency.

Fig. 1. Allocative and Technical Efficiency in the Case of One Output and Two Inputs



TC = total variable cost; I = unit isoquant

Source : Sadoulte and Janvry, 1995, p. 243

Let x_1 and x_2 be quantity of two variable inputs and y be total output; maximum efficiency in production is achieved when the producer is on the best production function (I_1).

Point A shows the most efficient production point because it is the intersection point of the isoquant curve I_1 (most efficient input utilization curve per unit of output) and the total variable cost curve TC_1 (minimum cost level). Line OP represents equal factor proportions i.e. all points along this ray have equal factor proportion.

If a certain firm is producing at point D, its inefficiency can be decomposed into TE and AE by using A as a reference point. TE of the firm at pint D in the factor space is the ratio of the lower total variable cost TC_3 and the observed variable cost TC_4 . This is the same as the ratio of line OF to OD. AE of the firm at point D can be seen either without assuming TE or by presupposing TE.

If we do not assume TE i.e. if we assume latest technology, point C represents the best allocatively efficient point because I_2 is tangent to the total variable cost line TC_2 , thus a firm that operate at point D is allocatively inefficient by $TC_4 - TC_2$. If we assume TE i.e. if we assume latest technology, the firm operating at point D is allocatively inefficient by $TC_3 - TC_1$.

A firm is economically efficient if it operates at point A where it is both technically and allocatively efficient. Based on Farrell's approach, Sadoulet and de Janvary (1995) summarized the technical and allocative efficiency of point D as follows:

1. $TE = TC_3/TC_4 = OF/OD$

2. $AE =$

- a) Based on latest technology $(AE_1) = TC_2/TC_4 = OG/OD$

- b) If TE is presupposed $(AE_2) = TC_1/TC_3 = OH/OF$

3. Economic efficiency

$$=TC_1/TC_4 = (TE) (AE_2)$$

3.1.2 PRIVATIZATION

3.1.2.1 DEFINITION

Different definitions of privatization have been given by different scholars. Rammand Ham (1989) classified three groups of privatization measure(Osma 1997) . The first group relates privatization to ownership and includes total denationalization (management buy-out , co-operatives and special share), joint venture and liquidation. The second group relates privatization to organizational changes to holding company structures and a uniform change of structures like leasing competition. The third and the final group relates privatization to investment criteria, pricing principles, resorting to the capital market, the rationalization of government control and incentive rewards.

Prager (1992), one of the researchers in the field of privatization , identified five possible definitions of privatization as follows ;

1. Privatization can be defined as the partial sale of state asset which does not imply attenuation of state control.
2. Privatization can be defined as change in ownership and control .
3. Privatization can be defined as private ownership (like leasing state owned enterprises) without any constraints on entry to the industry.

4. Privatization can be defined as changes only in patterns of control rather than ownership
5. Privatization as the transfer of production (like management contracts and contracting) in private hand while ownership and key decision making remain in the hands of the state.

Bos (1991) defined privatization narrowly as the sale of public sector assets and issues such as contracting out, debureaucratization and promotion of competition by market forces are excluded from the definition.

For the purpose of this study we define privatization as the transfer, through sale of enterprises or its unit or asset or government share holdings in a share company to private ownership of public enterprises. In general privatization involves the following three stages:

- The first stage is preparation, this includes analyzing and valuing of enterprises, determining the appropriate privatization modality, and doing any necessary enterprise restructuring.
- The second stage is implementation, here agreed modality is implemented.
- The third stage is post-privatization, this includes evaluation of the impact of privatization, monitoring investors obligation and enforcing if obligation is not satisfied.

3.1.2.2 FUNDAMENTALS OF PRIVATIZATION

Conventional privatization theory has three basic fundamental theories². These are:

- Public choice theory
- Property rights theory
- Principal-agent theory

PUBLIC CHOICE THEORY

The idea under public choice theory is that government bureaucrats are self-interested individuals, interested in maximizing their own welfare than that of society. This means that government staff aim to maximize their own welfare rather than maximize some notion of social welfare. With this regard as the government has more monopoly power, the more likely that the government overspend.

Public choice theory goes beyond the boundaries of enterprises into political structure. Politicians will monitor loosely so that they could favor their voters in the re-election process. Within public choice framework there is the concept of rent-seeking which is the source of inefficiency associated with the public sector. That is due to underground action resulted from rent-seeking behavior, distortions and inefficiencies emerge.

The advantage of privatization is therefore, it reduces the extent of using enterprise for individual or political purpose. This means privatization shifts this individual profit maximizing

² Source: Kate Bayliss (2000) Public Enterprise Reform and Privatization, a training manual.

behavior to productivity.

PROPERTY RIGHT THEORY

Property right theory rests on the idea that a private owner with profit maximizing motive will exercise greater effort in monitoring than the public sector. This is due to the fact that in the public sector there is no specific body with direct right to monitor. According to Coase, direct ownership of property which is tradable will improve monitoring of its performance.

In state ownership, ownership is not transferable and no-one has a well-defined claim if government output increases. No official is rewarded if he/she performs efficiently or punished if he/she wastes resources. Privatization has the tendency to define property right and reduce inefficiency associated with monitoring problem.

PRINCIPAL-AGENT THEORY

The idea under principal-agent theory is based on the incentive problem due to information asymmetry. The agent is enterprise manager who performs a service to the principal (public or private). Under this theory it is assumed that both the principal and the agent maximize their own wealth.

Under state ownership the principal is the government and the agent is the state employee. Since both the principal and the agent has different objectives, there is a strong incentive and monitoring system to make sure that the agent performs what the principal expects to perform. Under state ownership it is difficult to set such monitoring mechanism since the objective of the state is not only profit maximization.

Under private ownership the principal agent problem also exists but it is not as serious as the public ownership. The objective of the private owner is profit maximization and it is possible to set up strong incentive mechanism to guarantee efficiency. Privatization therefore has the potential to reduce this principal agent problem and thus increase efficiency.

According to the above three fundamentals of privatization theories, there is a problem under state ownership due to self interested bureaucrats and multiple objectives of running state owned enterprises.

If enterprises are privatized, multiple objectives of an enterprise is replaced with single profit maximizing objective and as a result monitoring will be tightened, accountability will be stepped up and poor performance can be penalized.

3.1.2.3 OBJECTIVE OF PRIVATIZATION

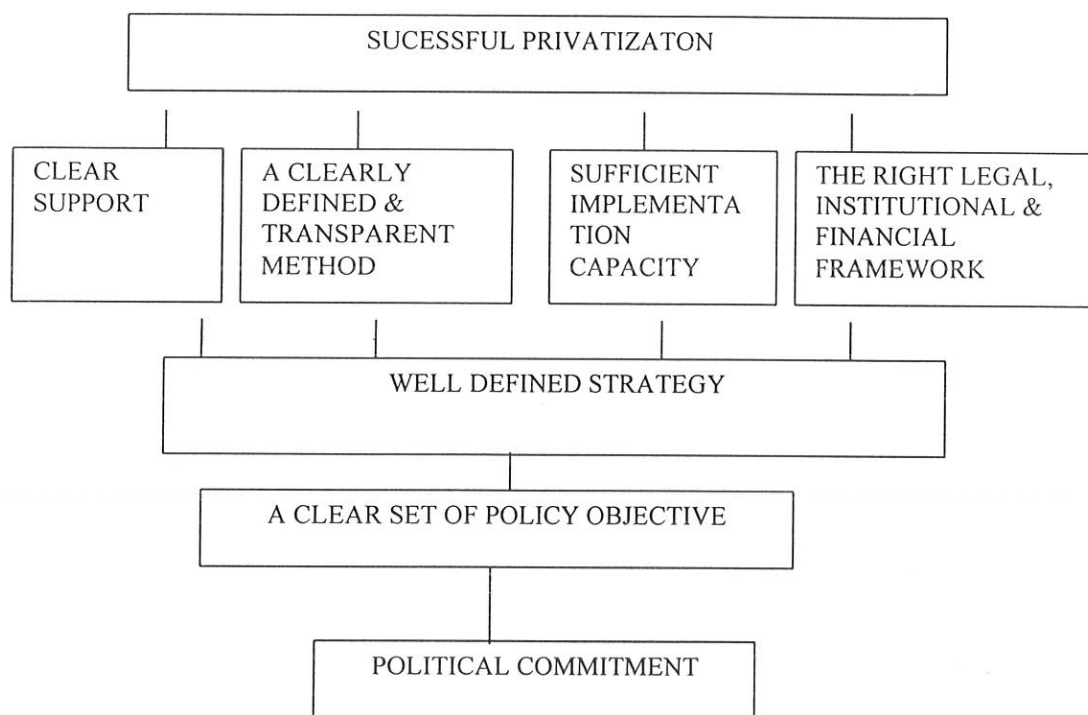
There are different objectives of privatization policy, These include the reduction of government

participation and public sector borrowing, the desire for creation of share owning democracy, to reduce the monopoly power of public sector trade unions and to increase efficiency and innovation.

In order to achieve the above objectives of privatization, increasing competition and rivalry is a necessary condition; if this is not satisfied the above objectives will not be compatible each other. For example reducing the size of public sector and maximizing treasury income from selling public asset will not be compatible with the efficiency objectives if the reduction of public sector size involves transferring monopoly power from the public to the private sector without increasing competition and rivalry. In general conditions for successful implementation of privatization program include the following points:

1. Governments should strengthen the role of the private sector in the national economy. The program requires high political commitment.
2. There should be effective and well functioning legal framework including property right, bankruptcy and privatization laws.
3. The existence of well developed financial sector and capital market is also necessity for successful privatization.
4. There is also a need to have competition and enabling environment for private sector investment.
5. The process and procedures in which privatization transaction are under taken should be transparent to the public and there should be a clearly established rules and regulations.

Building blocks of successful privatization is presented in the above diagram.



Source: Ethiopian privatization program executive summery, Price Waterhouse (1998).

The actual extent and shape of privatization will be determined by the preference of agents in politics. In democracies, these include bureaucracies aiming to maximize their budget and from interest groups so that they protect their position (like income and job tenure) and government seeking votes. Although privatization is implemented for one or more of the above objectives, the most part of the debate about privatization focus on enterprise performance or efficiency .

3.1.2.4 PRIVATIZATION AND MARKET STRUCTURE

The success of privatization program is also depends on market structure of the economy. Economic performance or TE not only depends on ownership change but also on market structure. In most developing as well as in some developed countries, there are restriction on the effectiveness of privatization due to lack of competitiveness; According to Suleiman and Waterbury, these are :

1. Small size of the middle income group who can acquire share
2. The thin spread or non-existence of capital market

With regard to economic and market structure , the following hypothesis on enterprise performance can be formulated ;

Ownership		Market	
		Monopoly	Competitive
	Public	A	C
	Private	B	D

Source : Privatization and development , Osama J.A.R,1997

- D is superior to C reflecting the standard economic view which favors competition.
- B is superior to A, reflecting the role of competition.

- D is superior to A, where D represent private ownership and a competitive market.

3.2 EMPIRICAL EVIDENCE

Advocates of privatization argue that private ownership restores incentives, which promote efficiency. Some studies that have relation to technical efficiency and privatization will be brought under this section.

Nosrarollah (1997) investigated whether there is any difference in technical efficiency between private and public firms and the relationship between technical efficiency and size for two hundred fifty textile companies in Iran for the period 1992. A non-parametric mathematical programming approach to frontier production function (DEA) has been used. He found that most of the enterprises operated at the efficiency level. Public firms were found to be inefficient compared to private firms and there existed a negative relationship between number of employees (labor) and technical efficiency indicating that smaller firms were more efficient than larger firms.

Jinjhai et.al (1997) investigated the effect of ownership structure on technical efficiency for seven three digit industries in China for the period 1986-1990 by using Data Envelopment Analysis (DEA) . The variables were taken at current price and it was found that state owned enterprises are less efficient compared to town village and collective enterprises. The scale of production was also positively correlated with technical efficiency.

Ephraim (2000) examined the impact of structural adjustment program on technical efficiency in Malawian manufacturing sector. He found that TE decline over time in the food processing, tea

processing and clothing and foot wear sub-sector while it increases for pharmaceuticals and soap sub-sector over time. He also found that TE significantly declines with firm size domestic monopoly power and tariff, while it is a positive function of factor intensity and skills of workers.

Kate et.al (1998) investigated the impact of privatization on enterprise performance in Ghana. They took one year data for before privatization and one year after privatization to 29 enterprises and made analysis by using different performance indicators. The result showed that there has been some success and some failure of privatization on performance. The failure of the program has been in encouraging domestic entrepreneurs and in elimination, reducing or regulating monopolistic enterprises.

Adam et al (1992) carried out case-study reviews of privatization in seven developing countries and concluded that privatization alone would have little effect unless there is a reform in market structures

Wiess (1995) studied the effect of ownership on performance for 500 largest industrial enterprises in Mexico. He took sales, sales per worker, and sales per total asset as performance indicator for the period 1985-90 and the cross sectional regression result showed that there was no significant relation between efficiency and ownership. The empirical study concluded that there was no support for the view that state ownership by itself implies a poor performance and factors such as economies of scale, market structure and industry trends may be more important in explaining a firm's performance than ownership type.

Christopher (1993) investigated whether there is efficiency gain due to privatizing the electric supply industry in England for one hundred eighty four observation by using stochastic trans-log average cost frontier for the period 1938 and 1985. Based on the likelihood ratio test for efficiency estimates, it was concluded that decentralized structure due to privatization was feasible and promoted efficiency.

Ravi (1997) analyzed the impact of privatization of Argentine railroads on its performance for the period 1965 to 1990. After doing the analysis, it has been concluded that large, unprofitable firms in developing countries faced with market failures can be privatized, but the gains from doing so depends on how the state enterprise was performing badly and the potential for introducing competition in the market.

Howard (1993) examines the current state and prospects for efficient development of the large-scale industrial sector in sub-Saharan Africa. It is explained that enhancing productivity , improving national environment and sectoral strategies are necessary in order for liberalization of trade bring successful development in sub-Saharan Africa.

Mohamed (1992) measured the average growth in productivity in public versus private 31 industries in Malaysia. He found that only in four industries private sector was found to be more efficient and 12 public industries were more efficient than private industries. He rejected the hypothesis that private industries are more efficient than public industries and concluded that the structure of the market is more important for efficiency.

Millward (1987) studied the comparative performance of public and private enterprises in less developed countries (LDCs) in terms of productivity and cost effectiveness over the period 1976-1986 . There was no statistically significant evidence that private enterprises in LDCs functioning at the same scale of operation as their counterparts in the public sector are technically more efficient (Osama 1997).

Rafael La Porta et.al (1999) investigated whether the increased profitability of privatized companies is at the expense of society or not by using data on 97 nonfinancial firms privatized in Mexico during the period 1983-1991. They used price increase and lower wages and lay off as social losses and found that after privatization there was a 24 percentage-point increase in the mean ratio of operating income to sales. Out of this higher product price explain 5 percent of this increase, transfers from laid-off workers contribute 31 percent of that increase and the remaining 64 percent is contributed by gain in productivity.

Balassa (1987) one of the strongest advocator of privatization, reviewed eight previous studies, which had compared the relative efficiency of public and private enterprises in developing countries and concluded that private enterprises are more efficient than public enterprises and privatization will enhance efficiency.

Hachette and Luders (1988) took a large sample of public and private enterprises in Chile during the period 1980-87 and they concluded that in five out of six large privatized enterprises, efficiency has increased due to privatization.

Cakmak and Zaim (1992) studied the efficiency of 17 public, 18 private and 6 mixed enterprises in 1990 of Turkish cement industry and compared their efficiency. They found that difference in ownership has no significant effect on economic efficiency of the different plants. They rather found that market structure or competition was the driving force behind improvements in the productive efficiency of these industries.

Ilokwu (1991) carried out a comparative analysis of 24 enterprises in Nigeria (12 public and 12 private enterprises) across four industries over the period 1980-1989 and reached the conclusion that public enterprises produced a lower performance and were less efficient.

Al Bavon (1998) examined the impact of ownership change on performance of firms in Ghana for the period 1986 to 1995 for 32 enterprises. After doing pooled time series analysis , he concluded that privatization of public enterprises and policies designed to increase competition has led to improvement in enterprises performance.

Battese and Lundavall (1999) did a study on firm size, age and efficiency for Kenyan manufacturing firms by applying trans-log stochastic frontier production function for unbalanced panel of 235 Kenyan manufacturing firms in the food, wood, textile and metal sectors separately. They investigated whether technical efficiency is related to age and size . It was found that firm size has positive and significant effect in wood and textile sectors and age is significant only in textile sector.

Taye (1996) did a study on the impact of firm age and size on technical efficiency by using stochastic frontier production method for 220 large and medium scale manufacturing firms and

found that firm size and age has a significantly positive effect on technical efficiency.

Collier et.al (2000) used a firm level panel data for manufacturing sector in four African countries (Cameron, Ghana, Kenya and Zimbabwe) to estimate the effect of exporting on efficiency. They used Cobb-Douglas stochastic frontier production model for the period 1992-1995. It was found that there was large efficiency gains from exporting in terms of levels and growth and evidence of a learning-by-exporting effect and self selection of the most efficient firms into exporting. The effect of export on efficiency was found to be large to African sample than in comparable studies of other regions and Africa has more to gain by molding its manufacturing sector towards exporting than other regions.

Pitt and Lee (1980) measured technical efficiency and source of inefficiency for fifty Indonesian weaving industry by using log linear Cobb-Douglas stochastic production model for the period 1972, 1973 and 1975. After running regression, it was found that larger firms are more efficient than smaller firms, younger firms were more efficient than older firms and domestically owned firms were more efficient than foreign owned firms.

Alemu (1992) investigated the relationship between efficiency of Ethiopian public manufacturing enterprises and the policy environment to which they were subjected for the period 1983 and 1988 by using allocative and technical(X) efficiency. It was also found that there was a divergence between economic and financial profitability due to government pricing and trade policy. Two groups that discouraged technical efficiency were identified and these are the organizational structure and the incentive system. It was concluded that first the incentive system should be linked with real measure of performance such as productivity, second rehabilitation and

restructuring of marginally inefficient enterprise is necessary to make them efficient and third avoiding discrimination in terms of policy among public firms and special treatment to industrial public enterprise like subsidized interest rate should be avoided .

Armando (1994) examined about the fiscal impact of privatization in Brazil in the 1990s. It has been found that due to the failure of the government's stabilization attempts the fiscal benefits of privatization has been reduced. As a result of this, government's capacity to impose limitation on buyers has been reduced and this has created the concentration of market power through acquisition of state-owned enterprises in a few individuals. It has been concluded that there is a need to establish a regulatory structure and a competition policy.

Page (1984) investigated the relation between relative technical efficiency and firm size in four Indian manufacturing sectors by using deterministic frontier translog production function for the period 1979-1981. After analyzing the data it was found that enterprise characteristics such as labor force stability, level of technology, age and capacity utilization were found as factors affecting technical efficiency. After controlling these firm characteristics, the relation between size and technical efficiency was investigated and there was no evidence of a systematic relationship between firm size and relative efficiency.

From the above review of literature in most cases privatization has improved TE of enterprises and market structure is also found to have greater contribution to this improvement.

CHAPTER FOUR

DATA AND EMPRICAL MODEL

4.1 DATA SOURCE AND COVERAGE

In order to start the analysis, firm level data on large and medium scale manufacturing is required. The main data source for this study is annual survey of large and medium scale manufacturing industries conducted by Central Statistical Authority (CSA) during 1992/93 to 1998/1999. The survey covers all large and medium scale manufacturing industries at national level.

The data was collected by trained enumerators and the supervision has been done by professionals in industrial statistics department. A number of quality control steps were taken to ensure the quality of data. The data were entered and verified by using Integrated Micro Computer Processing System (IMPS). Other data required for the study is taken from Ministry of Economic Development and Co-operation (MEDaC).

This study covers data on large and medium scale manufacturing industries (establishments that use power driven machine and engage more than 10 persons) that have been privatized with in the period 1992/93 to 1998/1999 is taken. The number of firms each year is 25 and the total number of observations being 175. Out of these 70 observation are from manufacture of food, 35 from beverage, 21 from textile and leather, 21 from chemical and printing, and 28 from wood and non metal sectors.

Since privatization is a time taking process, all firms were not privatized at the same period of time. Due to this fact, the change in ownership structure of each firm did not take place at the same time. The percentage distribution of public and private firms during the study period is presented in table 4.1.

Table 4.1: Percentage distribution of Ownership change for firms under the study.

Year	Public enterprises in percent	Private enterprises in percent
1992/93	100	0
1993/94	100	0
1994/95	100	0
1995/96	84	16
1996/97	48	52
1997/98	20	80
1998/99	0	100

Source : own computation.

As can be seen from the above table, 36 per cent of firms were public for 4 years and become private for 3 years where as 16 per cent of firms were public for 3 years and become private for four years.

4.1.1 DEFINITION OF DATA VARIABLES

Definition of data variables is presented as follows³:

An Establishment is defined as the whole of the premises under the same ownership or management at a particular address.

Public sector under this sector all establishments owned by the state i.e., those which were fully as well as partially (with 51 percent share and above) owned by the government are included.

Private sector includes establishments such as individual ownership, partnership, private limited company, share company, co-operatives, and others.

Number employed includes all persons on the payroll whether seasonal or temporary workers. The number of seasonal and temporary workers has been adjusted to give equivalent of full-time workers.

Number engaged includes paid employees and working proprietors, active partners, an unpaid family workers.

Wage and salaries includes all payments in cash or in kind made to employee during the reference year in connection with work done for the establishments.

Revenue from sale represents the total sales value of all products during the reference year valued at market price.

³ These definitions are also used by CSA in the annual large & medium scale manufacturing survey.

Industrial cost includes the cost of raw materials , fuel , and other supplies consumed and cost of industrial services rendered by others.

Fixed Capital Asset are those with a productive life of one year or more which are intended for the use of the establishment and they are valued at book-value of the reference year (i.e net book value plus capital expenditure minus those disposed and sold and depreciation.

4.1.2 DESCRIPTIVE ANALYSIS OF THE DATA

The data is grouped into food processing sector, beverage sector, textile and leather sector, chemical and printing sector, and non-metal and wood sector. Since the raw data is value at current price, it is converted to constant price by deflating with the appropriate deflator. Implicit sectoral deflator is used to deflate gross value of output and intermediate input, wage index is used to deflate wage and salaries and investment deflator is used to deflate fixed asset.

The data shows some variation across all variables in all sectors and the descriptive statistics for the variables are presented in table 4.2 below. From the nature of the data in food processing sector, we see that 50 percent of the firms are meat processing industries , 20 percent are oil producing industries , 20 percent are flour producing firms and 10 percent of the firms are pasta and macaroni producing industries . The minimum gross value of out put is 337 thousand Birr where as the maximum is 324 million Birr. Compared to beverage and textile sectors, firms under food processing sector are relatively small compared to beverage and textile sectors .The smallest plant in the food processing sector employs 37 workers where as the largest employs 747 workers.

In the beverage sector, 75 percent of the firms are soft drink producing firms and 25 percent of the firms is beer manufacturing firm. Under this sector, the standard deviation is larger than the mean for gross value of out put, industrial cost and capital and it is smaller than the mean for labor, size and age. The minimum gross value of output is 2.29 million Birr where as the maximum value is 1.1 billion Birr . The smallest plant in the beverage sector employs 172 workers where as the largest employs 1512 workers and the variation in employment is relatively small compared to food processing sector.

In the non-metal and wood sector, 33.3 percent of each firms produce cement, wood and mineral. The maximum gross value of out put is 104 million Birr and the minimum gross value of out put is 20.3 thousand Birr which is an indication of large variation in gross value of production . For the variables like labor, size and age the standard deviation is smaller than the mean and it is larger than the mean for gross value of out put, industrial cost and capital. The smallest establishment employees 44 workers where as the largest employees 797 workers.

In the textile and leather sector, 66.67 percent of firms produce leather and 33.3 percent of the firms produce textile. Under this sector, the standard deviation is larger than the mean for industrial cost and capital where as it is smaller than the mean for gross value of out put, labor, size and age. The minimum gross value of out put is 311 thousand Birr and the maximum is 208.9 million Birr which shows a wide variation in gross value of output. The smallest firm employees 306 workers while the largest employ 884 workers. The variation in size is not large as compared to food, beverage, and non-metal and wood sectors.

In the printing and chemical sector, 33.3 percent of each firm produce ink, soap and plastic. Under this sector, the standard deviation is larger than the mean for gross value of output, industrial cost and capital and it is smaller than the mean for labor size and age. The minimum gross value of output is 871.3 thousand while the maximum is 137.3 million and this shows a large variation in gross value of production. The largest firm employs 247 workers and the smallest firm employ 26 workers and compared to other sectors, the variation is smaller.

Table 4.2: Descriptive Statistics for the variables under the study

<i>FOOD</i>	<i>GVP</i>	<i>IND.COST</i>	<i>LABOR</i>	<i>CAPITAL</i>	<i>SIZE</i>	<i>AGE</i>
Mean	31378.8	3429.4	1018.3	5271.5	320	35
Standard Deviation	67000.5	8457.8	643.4	9670.7	323	12
Minimum	337.0	28.8	88.2	183.1	37	21
Maximum	324486.8	64860.9	2697.3	49513.5	747	63
<i>BEVERAGE</i>	<i>GVP</i>	<i>IND.COST</i>	<i>LABOR</i>	<i>CAPITAL</i>	<i>SIZE</i>	<i>AGE</i>
Mean	138005.3	11051.5	3546.8	12535.7	569	34
Standard Deviation	219556.7	17225.3	2202.7	15928.4	350	21
Minimum	2298.472	281.5	658.5	871.4	172	8
Maximum	1132570	80821.6	8866.2	62317.7	1512	74
<i>WOOD& NON-METAL</i>	<i>GVP</i>	<i>IND.COST</i>	<i>LABOR</i>	<i>CAPITAL</i>	<i>SIZE</i>	<i>AGE</i>
Mean	16716.4	1921.5	1461.0	7047.8	341	34
Standard Deviation	24174.5	2502.9	844.6	7203.2	171	8
Minimum	20.3	2.6	2.1	6.1	44	23
Maximum	104820.0	9136.2	2617.6	23388.5	797	47
<i>TEXTILE & LEATHER</i>	<i>GVP</i>	<i>IND.COST</i>	<i>LABOR</i>	<i>CAPITAL</i>	<i>SIZE</i>	<i>AGE</i>
Mean	62153.9	3930.089	3034.411	10940.08	508	22
Standard Deviation	60630.33	7096.981	2507.711	18456.97	229	8
Minimum	311.0644	21.977	459.436	507.755	306	9
Maximum	208981.3	29143.87	8866.186	69563.83	884	34
<i>PRINTING & CHEMICAL</i>	<i>GVP</i>	<i>IND.COST</i>	<i>LABOR</i>	<i>CAPITAL</i>	<i>SIZE</i>	<i>AGE</i>
Mean	27593.4	5268.138	754.201	4109.987	126	26
Standard Deviation	37311.95	10313.19	400.979	6335.018	62	7
Minimum	871.311	12.553	126.469	249.635	26	14
Maximum	137310.5	38948.67	1495.177	20537.34	247	36

Value is in 000'S except size and age.

Source : Own computation

GVP = Gross value of production

IND.COST = Industrial cost

4.2 EMPIRICAL MODEL

4.2.1 MODEL SPECIFICATION

In order to measure the impact of privatization on technical efficiency, stochastic frontier model [Battese and Coelli, 1993,1995] is applied for large and medium scale manufacturing firms. Technical inefficiency effects are specified as function of other variables and the parameters of frontier production are estimated simultaneously.

The stochastic frontier production model defined by Battese and Coelli (1995) follows,

$$Y_{it} = f(X_{it}; \beta) + e_{it} \quad \dots\dots\dots (1)$$

Where Y_{it} = Output of the firm I ($I=1,2,\dots,N$) at time t ($t= 1,2,\dots,N$)

$F(.)$ = The production technology.

X = A vector of n inputs .

β = Vector of unknown parameter to be estimated.

The error term e_{it} is specified as $e_{it} = v_{it} - u_{it}$ where v_{it} is statistical noise and u_{it} is technical inefficiency. The error term e_{it} will take care of the deviation of the actual output from the frontier . The deviation of the actual production level from frontier is due to two factors ; these are factors out of the reach of the decision-maker and/or due to human error.

From the above : $e_{it} = V_{it} - U_{it}$

Where V_{it} is symmetric component which measures exogenous shock and statistical error and U_{it} is one sided component ($u_{it} \geq 0$) which captures the divergence of the actual from the best practice or technical inefficiency relative to the stochastic frontier.

Therefore in this model technical inefficiency is specified as

$$U_{it} = \sum \delta z_{it} + w_{it}, u_{it} \geq 0 \dots\dots\dots (2)$$

Where z_{it} is factor affecting TE of firms ;

δ is a parameter coefficient to be estimated.

This is obtained by following original Farrell (1957) concept as follows

$$TE = e^{U_{it}} = \alpha (X_{ijt})^{B_j} e^{U_{it} + V_{it}} / \alpha (X_{ijt})^{B_j} e^{V_{it}}$$

$$= \text{Actual output/ Potential output} \dots\dots\dots(3)$$

TE is one for fully efficient firms , in the interval between zero and one for firms with some degree of technical inefficiency with production and zero for firms with no technical efficiency. Firm level technical efficiency will be obtained by calculating the mean conditional efficiency of U_i given the total error.

$$E(U_i / (U_i + V_i)) = \delta u \delta v / \delta [\phi() / 1 - \phi()] - (U_i + V_i) / \delta (\gamma / 1 - \gamma)^{1/2}] \dots\dots\dots (4)$$

Where $\gamma = \delta_u^2 / \delta^2$, $\delta^2 = \delta_u^2 + \delta_v^2$, Φ, ϕ are standard normal density and cumulative distribution function evaluated at $[(u + V) / \delta] [(\gamma / (1 - \gamma))]^{1/2}$

Based on the above theoretical concept of measuring technical efficiency the model (Bttese and Lundvall ,1999) is given as :

$$\ln Y_{it} = (b_0 + \sum_{j=1}^n b_j X_{jit} + \sum_{j \leq k=1}^n \sum_{j \leq k=1}^n b_{jk} x_{jit} x_{kit}) + v_{it} - u_{it} \dots\dots\dots(5)$$

Where the subscripts , i and t are the observation for the i-th firms
(I= 1,2,.....N) and year (t= 1,2,3,....) respectively.

$\ln Y_{it}$ = The natural logarithm of output;

X_{1t} = The natural logarithm of industrial cost; at time t.

X_{2t} = The natural logarithm of wages; at time t

X_{3t} = The natural logarithm of capital; at time t

V_{its} are random error is assumed to be independently and identically distributed with mean zero and variance δ_v^2 ; and

the U_{its} are non-negative random variables and are assumed to be independently and identically distributed with truncation (at zero) of the normal distribution with mean μ_{it} and variance δ_u^2 .

Where μ_{it} is defined by

$$\begin{aligned} \mu_{it} = & \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 z_1^2 + \delta_4 z_2^2 + \delta_5 z_1 \times z_2 + \delta_6 t + \delta_7 D_{1it} \\ & + z_1 \times z_3 + \delta_9 z_2 \times z_3 \dots\dots\dots(6) \end{aligned}$$

Where,

z_1 represents firm size, which is number of workers engaged ;

z_2 represents firm age ,which is the number of years of operation of the firm;

z_1^2 represents firm size squared;

z_2^2 represents firm age squared ;

$z_1 \times z_2$ represents firm size multiplied by firm age.

D_{it} represents ownership dummy; where $D = 1$ for private and $D = 0$ for public.

t represents time period .

Size and age are entered in the function because they affect TE of firms in most cases and time is entered in the function to allow for possible shifts in the frontier over time and the parameters involving the input variables are assumed to be time-invariant. The squares and interaction between age and size are included to allow for joint relationships between the two variables and the technical inefficiency effects.

CHAPTER FIVE

EMPRICAL RESULTS

5.1 INTRODUCTION

The maximum likelihood estimation is made in five sectors separately. Firms are classified into their respective sectors so that similar firms with respect to technology, output production property are compared. This will make comparing TE of each firm appropriate. The five sectors are; food, beverage; textile and leather, chemical and printing, and non-metal and wood. For each sector, a test is made to identify whether Cobb-Douglas or translog production function is the appropriate model. Generalized likelihood ratio test for different null hypothesis is presented in table 5.1 and as can be seen from the table, for food, textile and leather, and printing and chemical sectors the null hypothesis which says Cobb-Douglas production function is the appropriate model is rejected at five percent. This means that the coefficients of the interaction variable is different from zero and the appropriate model for these sectors is found to be translog stochastic frontier model. For beverage and non-metal and wood sectors the null hypothesis which says Cobb-Douglas technology is not rejected and therefore Cobb-Douglas production function is found to be the appropriate model. As we have seen the type of model differ for two groups of sector and

this shows that pooling of the data into one group is not appropriate.

Table 5.1: Generalized likelihood –ratio test of null hypothesis for parameters in the stochastic frontier production function⁴⁵

Null Hypothesis, Ho	Food	Beverage	Chemical & printing	None Metal and Wood	Textile & Leather	Critical value ω
$\beta_{ij} = 0, i, j = 1, 2, 3, \dots, 6$ (Cobb-Douglas function)	19.32	0.26*	29.45	3.62*	24.62	12.59
$\gamma = 0$ (No inefficiency effect)	55.4	27.94	37.67	14.94	37.6	3.84
$\mu_u = 0$ (Half normal distribution)	15.8	7.88	1.54*	7.8	20.52	3.84
...						

ω = The critical value at 5 percent is given and Values that do not exceed critical value at 5% are marked by an asterisk (*).

Source: own computation

After testing the correlation among the variables and dropping some of the variables with highest correlation (here variables with correlation 0.99 are dropped) see appendix 14-18. Final model for food, textile and leather and printing and chemical sectors is given by:-

$$\ln Y_{it} = b_0 + b_1 x_{1it} + b_2 x_{2it} + b_3 x_{3it} + b_{12} x_{1it} x_{2it} + b_{13} x_{1it} x_{3it} + b_{14} x_{2it} x_{3it} \dots \dots \dots (1)$$

$$\mu_{it} = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 t + \delta_4 D_{1it} \dots \dots \dots (2)$$

The model for beverage and non-metal and wood sectors the model is given as

$$\ln Y_{it} = b_0 + b_1 x_{1it} + b_2 x_{2it} + b_3 x_{3it} \dots \dots \dots (1)$$

$$\mu_{it} = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 t + \delta_4 D_{1it} \dots \dots \dots (2)$$

⁴ This test is also made after variables with multicollinearity are dropped and the results are found to be the same for log likelihood function see appendix 1,2,3.

$$\mu_{it} = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 t + \delta_4 D_{lit} \dots\dots\dots(2)$$

The above two equations are estimated simultaneously for each group by using a computer software program Frontier 4.1(Collie 1994). A test whether average production function or stochastic frontier best describe the data is made by using the generalized likelihood ratio test . As can be seen from table 5.1, the null hypothesis which says gamma equals to zero is rejected at 5% for all sectors and this shows that there exist some inefficiency among firms. Therefore using the average production (normal OLS) means assuming efficiency which is not correct according to the above test and therefore stochastic frontier model is found to be the appropriate model.

A generalized likelihood ratio test whether half-normal or truncated normal assumption best describes the data has also been made. As can be seen from table 5.1, the null hypothesis of half normal distribution ($\mu_{it} = 0$) is not rejected at 5% only for chemical and printing sectors.

For food, beverage, textile & leather and chemical & printing sectors, the assumption of truncated normal distribution is not rejected and the discussion of the results is based on this assumption. For chemical and printing sector the discussion of the results will be based on half-normal distribution of the asymmetric error term (μ_{it}).

In a frontier production model it is more appropriate to rely on a generalized likelihood ratio test than the calculated t-statistics (Bates & Lundvall 1999) and therefore in order to see the significance of factors affecting technical efficiency, a generalized likelihood ratio test is made

and summarized under table 5.3.

5.2 ANALYSIS AND INTERPRETATION OF THE RESULT

The analysis of the results will be made according to the five sectors estimated. The maximum likelihood estimation result of the chosen model for each sector is presented in table 5.2. Even though the chosen model is presented in table 5.2, the maximum likelihood result for average production function, stochastic frontier production function with the assumption of half normal distribution, and for stochastic frontier production function with the assumption of truncated normal distribution , and the maximum likelihood result including all variables with multicollinearity is estimated for each sector attached in the appendices.

In most similar studies the analysis and interpretation of the result focuses on the second inefficiency model. This study also focuses on the second model since the main target of the study is on measuring TE and analyzing what factors affect TE of firms. The result with multicollinear variables and without those variables is shown in the appendices and as can be seen there is no difference in the sign of the variables in the inefficiency model . However the difference exist in the first model i.e. if multicollinear variables are included , most of the variables become insignificant in the first model.

Table 5.2: Maximum likelihood result of stochastic frontier production function with the assumption of truncated normal & half normal distribution.

Variables	Food	Beverage	Printing & chemical	None Metal and Wood	Textile & leather
	SFTN	SFTN	SFHN	SFTN	SFTN
CONSTANT	2.05 (2.37)	6.29 (1.92)	-36.6 (-37.8)	0.39 (0.019)	-30.5 (-20.86)
INDUSTRIAL COST (IC)	0.38 (0.83)	0.53 (4.4)	-0.84 (-5.35)	0.64 (6.72)	0.62 (1.25)
LABOR	1.93 (5.16)	0.08 (0.22)	7.60 (34.8)	0.42 (2.53)	8.01 (13.75)
CAPITAL	-0.64 (1.65)	0.056 (0.52)	5.25 (32.6)	0.0034 (0.026)	0.87 (1.45)
(IC)(LABOR)	-0.16 (-2.57)	-	-0.08 (-2.14)	-	-0.51 (5.34)
(IC)(CAPITAL)	0.16 (3.83)	-	0.24 (6.39)	-	0.46 (6.62)
(LABOR)(CAPITAL)	-0.047 (-0.69)	-	-0.90 (-34.2)	-	-0.48 (-7.71)
INEFFICIENCY MODEL					
CONSTANT	1.83 (7.8)	4.24 (4.16)	-	4.38 (0.012)	7.97 (3.95)
SIZE	0.0004 (1.43)	-0.014 (-1.61)	0.09 (2.69)	-0.017 (-2.85)	0.007 (1.15)
AGE	0.025 (5.3)	-0.03 (3.08)	-0.14 (-8.91)	-0.045 (-2.95)	-0.42 (-3.01)
TIME	-0.13 (-1.98)	-0.53 (-3.84)	-0.003 (-0.012)	-0.028 (-0.34)	-1.8 (-3.03)
OWNERSHIP DUMMY	-1.68 (-4.03)	0.34 (0.60)	3.16 (4.47)	0.004 (-0.11)	2.32 (1.15)
VARIANCE PARAMETER					
$\delta^2 = \delta_v^2 + \delta_u^2$	0.52	0.29	0.67	0.21	2.23
$\gamma = \delta_u^2 / \delta^2$	0.99	0.23	0.99	0.26	0.99
Log-likelihood Function	-62.7	-26.5	-0.73	-18.	-10.4
MEAN TE	0.26	0.59	0.67	0.13	0.63

Source: own computation

SFTN = Stochastic frontier with the assumption of truncated normal distribution.

SFHN = Stochastic frontier with the assumption of half normal distribution.

Table 5.3: Generalized likelihood –ratio test of null hypothesis for parameters in the inefficiency model.

Null Hypothesis, H_0	Food	Beverage	Chemical & printing	None Metal and Wood	Textile & Leather	Critical value ω
$\delta_1 = 0$ (no size effect)	2.62*	1.96*	3.88	6.88	7.82	3.84
$\delta_2 = 0$ (no age effect)	11.18	3.26*	11.8	7.3	12.56	3.84
$\delta_4 = 0$ (no time effect)	0.92*	9.92	2.38*	0.02*	19.02	3.84
$\delta_5 = 0$ (no ownership effect)	19.02	12.06	2.12*	0.64*	17.2	3.84

ω = The critical value at 5 percent is given . Values that do not exceed critical values at 5% are marked by an asterisk (*).

Table 5.4: Descriptive statistics for TE in each sector

<u>TECHNICAL</u> <u>EFFICIECN</u>	<i>FOOD</i>	<i>BEVERAGE</i>	<i>PRINTING & CHEMICAL</i>	<i>NON-METAL & WOOD</i>	<i>TEXTILE & LEATHER</i>
Mean	0.26	0.59	0.67	0.68	0.63
Standard Deviation	0.28	0.32	0.26	0.32	0.29
Minimum	0.11	0.15	0.10	0.11	0.21
Maximum	0.99	0.97	0.99	0.99	0.95

5.2.1 FOOD PROCESSING

As explained in section 5.1, the appropriate model chosen for food processing sector is a translog stochastic frontier model with the assumption of truncated normal distribution. A generalized likelihood ratio test for the factors affecting technical efficiency is made and summarized in table 5.3.

From table 5.3, the null hypothesis which says no size ($\sigma_1 = 0$) and no time ($\sigma_4 = 0$) effect is not rejected at 5% which means size and age are insignificant. The null hypothesis of no age ($\sigma_2 = 0$) and no ownership ($\sigma_5 = 0$) effect is rejected at 5% which implies that age and ownership dummy are significant. Not rejecting the null hypothesis of no size effect implies that a small size firm can be as productive as large size firm in the food processing sector. In other words, the firm employing 37 workers (the smallest size firm) and the firm employing 747 workers (the largest size firm) could have the same level of efficiency if other factors affecting efficiency remain constant.

Time in this model captures the movement of TE of firms during the study period. As the result indicated time is insignificant in food processing sector.

The sign of age is positive and significant which means that as the factory's age increases, efficiency declines. This may be due to the fact that machine depreciation and out dated technology outweighed the efficiency that could have been gained due to experience through time. If we look at the impact of change in ownership on technical efficiency from table 5.2, the

sign of ownership dummy in the inefficiency model is negative which means that there was improvement in technical efficiency due to privatization (since $D = 0$ for public & $D = 1$ for private) and this result fits with our expectation in the hypothesis. One of the explanations for this may be the nature of structure of ownership of firms allows competition under the sector. Fifty percent of firms were bought by different owners while the remaining 50 percent (in which all are meat processing industries) are owned by a single owner. If we look at the scale of industries under this sector their size is relatively small compared to other sectors like beverage and textile and leather sectors. As the firm size is small, its sale value is relatively small and this will make domestic investors (individual) participate in the buying process. This could be one of the reasons why different domestic investors participated in the privatization of food processing sector.

The other reason may be the improvement in output with decreasing new capital investment. According to EPA privatization criteria, there has not been any capital expansion criteria set in the food processing sector. If we look at figure 2 below, output has been increasing while new capital investment was declining specially after period 5 where most of the firms have been privatized and change their ownership from public to private. This implies that the available capital has been utilized to produce more output than increasing capital investment after privatization and this could be one of the reasons for the improvement in TE after ownership change.

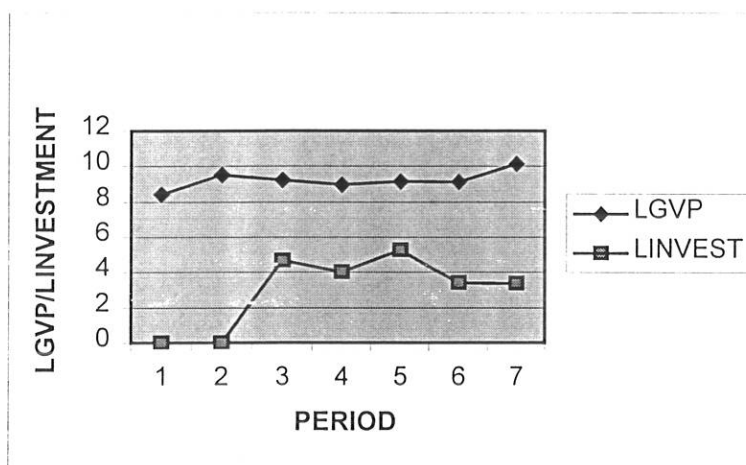


Figure 2: Output & investment for food processing sector.

If we look at the descriptive statistics of TE from table 5.4, mean TE of food processing sector is found to be 0.26 and this shows that firms in food processing sector can increase the level of their output on average by 0.74 percent without absorbing further resources. The minimum TE level is found to be 0.01 and the maximum is 0.99 and this shows there has been a wide range of difference in TE of firms during the study period. The line graph under figure 3 below shows that for most of the firms an increase in TE is seen after period 5. For other periods, however there have been ups and downs in TE of most of the firms.

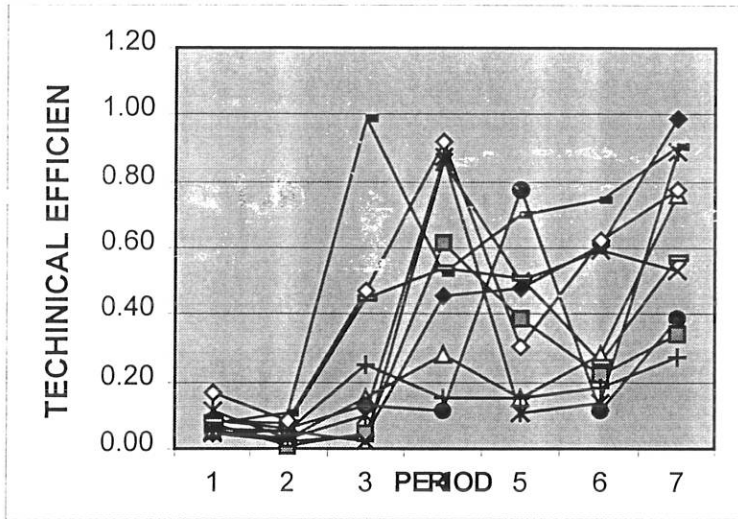
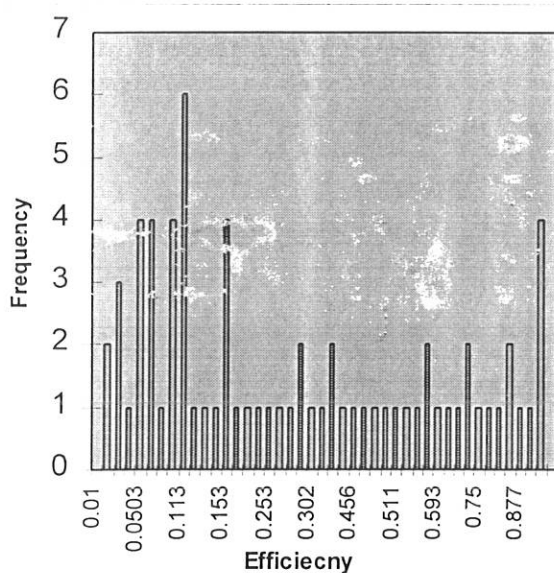


Figure 3 :TE of firms in food processing sector for study period

From figure 4 below, the distribution of TE seems negatively skewed and this implies that firms have been operating below 0.3 TE level.



5.2.2 BEVERAGE

As explained under section 5.1, the appropriate model chosen for beverage sector is a Cobb-Douglas stochastic frontier model with the assumption of truncated normal distribution. A generalized likelihood ratio test for the factors affecting technical efficiency is made and summarized under table 5.3. The result shows that the null hypothesis of no size and age effect is not rejected at 5% which means that the variables are not significant. The null hypothesis of no time and no ownership effect is rejected at 5% which means that the variables are significant.

Like food processing sector, size does not affect TE in beverage sector. Age is found to be insignificant in this sector and this may be due to the fact that the gain in TE due to experience through time is balanced with the loss in TE due to depreciation of machinery.

The sign of ownership dummy from table 5.2 in the inefficiency model is found to be positive which means technical efficiency of firms in the beverage sector has decreased because of change in ownership from public to private. One of the explanations for this may be the nature of structure of ownership of firms does not allow for competition.

Seventy five percent of soft drink producing firms are owned by single owner .One of the reasons for this could be the size of firms under this sector was relatively large compared to other sectors and this made them unaffordable to individual domestic investors to participate in the privatization process. As a result, there has been some what semi-monopolistic market structure under the sector.

According to EPA privatization criteria for the beverage sector, the buyer is required to make some capital expansion. If we look at figure 4 below, output and investment show some what similar trend for most of the periods except investment decreased while out put increased for period 4 and investment increased while output decreased for period 7. Ownership change occurs after period 4 and as we can see from the figure 5, the general trend shows an increasing investment and a decreasing output after this period. Investment growth rate has also increased much faster than output growth rate. This could some what shows that instead of producing more out put with the available capital, firms have been producing less out put with more capital after ownership has changed from public to private.

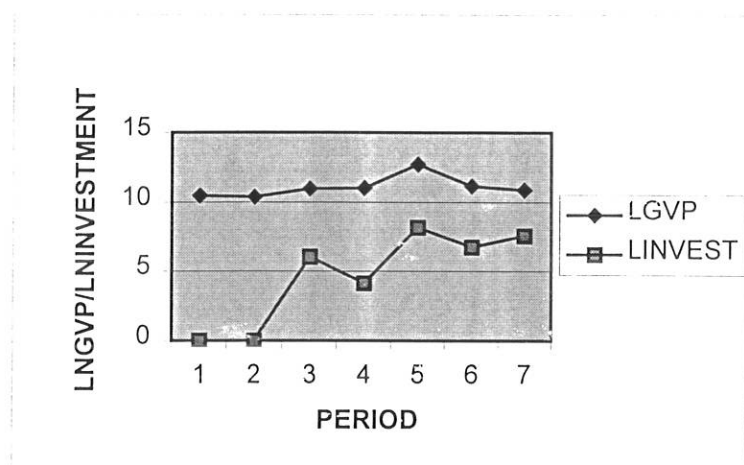


Figure 5 : Output & investment in beverage sector.

The minimum TE during the study period is 0.07 where as the maximum is 0.97 and we can say that there is a wide difference in the level of TE of firms through time. However as we can see from the line graph under figure 6, the increment in TE has been smooth during the study period and there is a tendency of most of firms to converge at the same TE level as time goes by . From table 5.2, the sign of time variable in the inefficiency model is negative and this means there has been an increasing trend in TE through time this may be due to other factors including policy changes like public reform program that gave public autonomy to each firms; under taken during the study period. This result is consistent with the smooth increment in TE through time under the graph below.

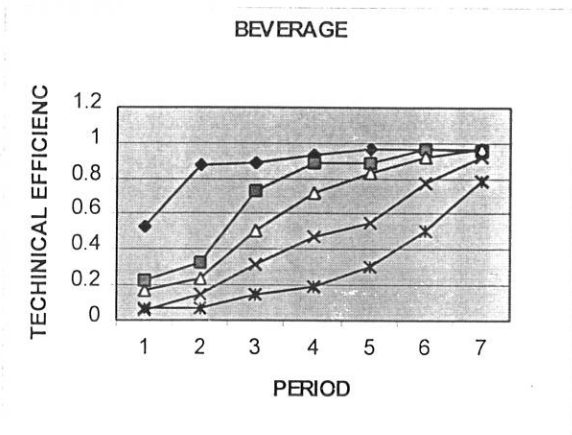


Figure 6: TE of firms for beverage sector in the study period

From table 5.4, mean TE of beverage sector during the study period is found to be 0.59 and this shows that there has been a possibility for privatized firms in beverage sector to increase the level of their output on average by 0.41 percent without absorbing further resources. The histogram under figure 7 shows some positive skewness and relatively large number of firms operate above 0.53 TE level.

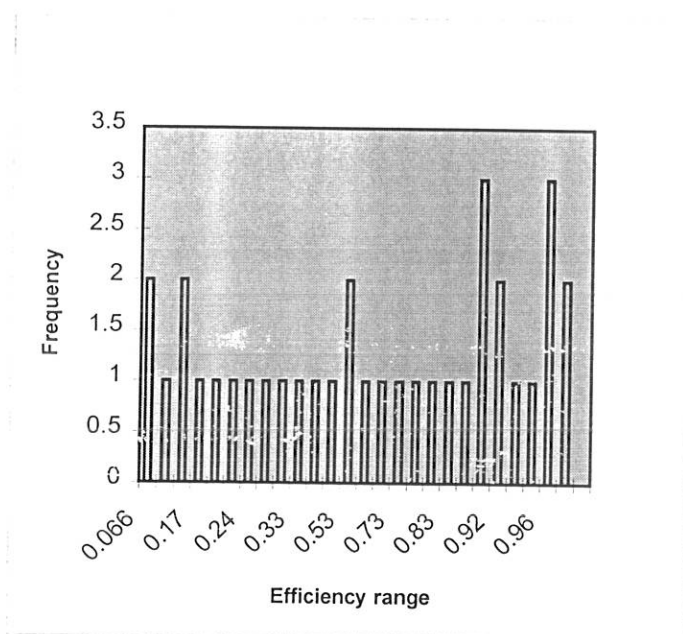


Figure 7: Frequency distribution of TE of firms in beverage sector

5.2.3 CHEMICAL AND PRINTING

The appropriate model chosen for chemical and printing sector is a trans log stochastic frontier model with the assumption of half normal distribution. A generalized likelihood ratio test for the factors affecting technical efficiency is made and summarized under table 5.3. The null hypothesis of no time and no ownership effect is not rejected at 5% which means the variables are not significant. The null hypothesis of no age and no size effect is rejected at 5% which means the variables are significant.

From table 5.2, size is found to have positive sign in the inefficiency model and this means that as the size of a firm increases, its TE decreases. From section 4.2.1, size has been measured by number of persons engaged and therefore negative significant effect of size on TE could indirectly show that there has been a redundancy of labor.

Time in this model shows movement of TE of firms through time in the study period. As the result indicated time does not have any significant contribution to the change in TE in chemical and printing sector.

The sign of age is negative and significant which means that as the factory's age increases, efficiency increases. This may be due to the fact that the efficiency gain due to experience through time is out weighted by the efficiency loose due to machine depreciation and out dated technology i.e. firms learn from there past experience and become more efficient than being inefficient due depreciation and out dated technology.

If we look at the impact of change in ownership on technical efficiency from table 5.2, it is found to be insignificant. This shows the level of technical efficiency does not show a significant change due to ownership change. The line graph under figure 8 below also shows that there has been no particular (either increasing or decreasing) trend on TE of firms .

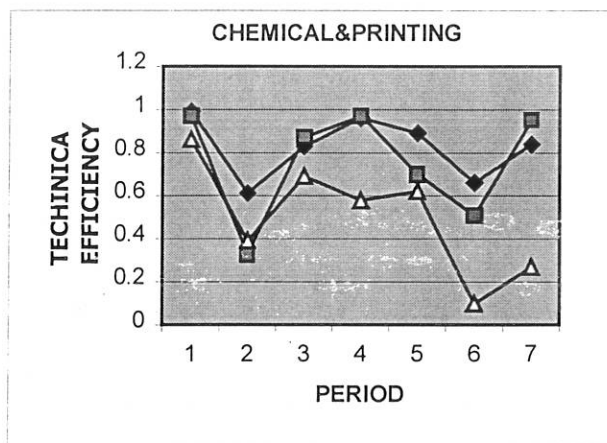


Figure 8: TE of firms in chemical & printing sector during the study period.

If we look figure 9 below, investment has not shown a specific pattern while output has shown a slight increasing trend. This could indirectly show that, rather than utilizing the existing capital and maximizing output, firms have been utilizing extra resource because output was not increasing largely in response to large increase in investment. This does occur in both ownership structures and this could indicate that one of the reasons for the existence of inefficiency in the sector could be output was not responsive to largely increased investment rather than change in ownership. The regression result also supports that change in ownership does not significantly affect TE of firms in the sector.

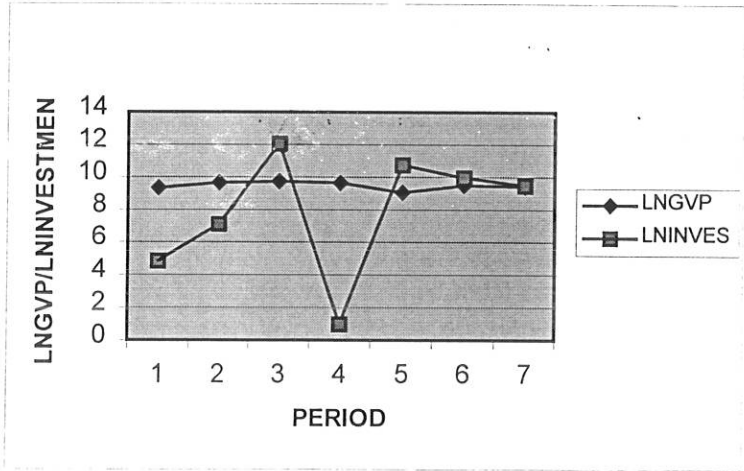


Figure 9: Output & investment in chemical & printing sector.

From table 5.4, mean TE in chemical and printing sector is 0.67 which shows that privatized firms in the sector can increase the actual level of output on average by 0.33 percent without absorbing further resources. The minimum TE level during the period is 0.1 where as the maximum is 0.99 and this shows a wide variation in firms TE level through time. The histogram under figure 10 shows some positive skewness and large number of firms operate above 0.53 TE level.

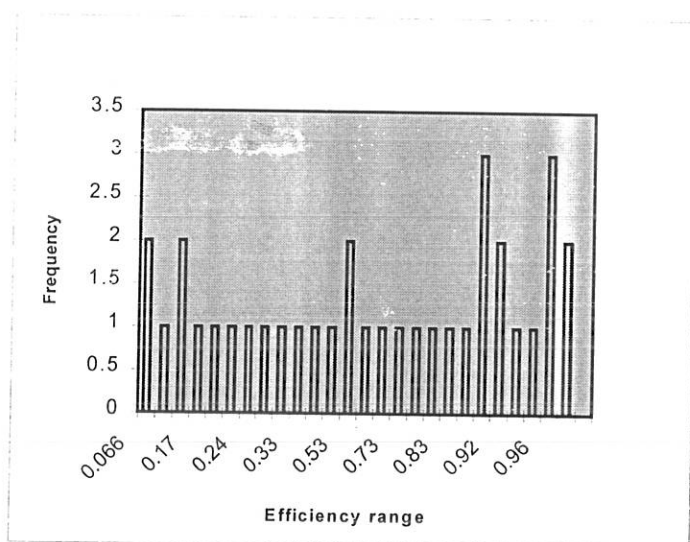


Figure 10: Frequency distribution of TE of firms in chemical & printing sector.

5.2.4 NON-METAL AND WOOD

The appropriate model chosen for non-metal and wood sector is Cobb-Douglas stochastic frontier model with the assumption of truncated normal distribution. From a generalized likelihood ratio test for the factors affecting technical efficiency on table 5.3, the null hypothesis of no time and no ownership effect is not rejected at 5% which means the variables are not significant. The null hypothesis of no age and no size effect is rejected at 5% which means the variables are significant.

As explained above, time shows the movement of TE of firms during the study period. The result has shown that time is insignificant in TE in non-metal and wood sector.

If we look at the impact of change in ownership on technical efficiency from table 5.2, it is found to be insignificant. This shows that the level of technical efficiency does not show a significant change due to ownership change. The line graph under figure 11 below shows that there has been no particular (either increasing or decreasing) trend on TE of firms during the period and this supports the result which says time is insignificant.

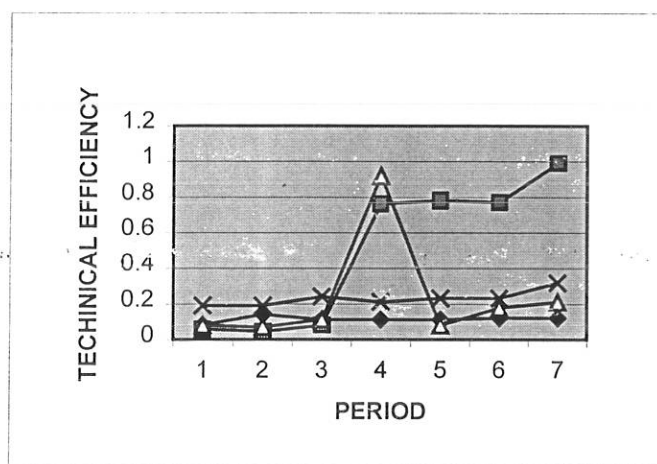


Figure 11: TE of firms in non-metal & wood sector for the study period.

From table 5.2, size is found to have negative sign in the inefficiency model and this means that as the size of a firm increases, its TE also increases. Since size has been measured by number of persons engaged, a positive significant effect of size on TE could indirectly show that there has not been a redundancy of labor in the sector.

The sign of age is negative and significant in the inefficiency model and this means that as the

factory's age increases, efficiency increases. This may be due to the fact that the efficiency gain due to experience through time out weighted the efficiency loss due to machine depreciation and out dated technology i.e. firms learn from there past experience and become more efficient than being inefficient due to depreciation and out dated technology.

If we look figure 12 below, investment has been increasing larger than output for most of the time. This shows that firms have been investing on new capital with out increasing output even though there was no investment criteria set by EPA. This may be due to the existence of some managerial inefficiency since firms have been investing extra resource with out utilizing the existing capital and maximizing output.

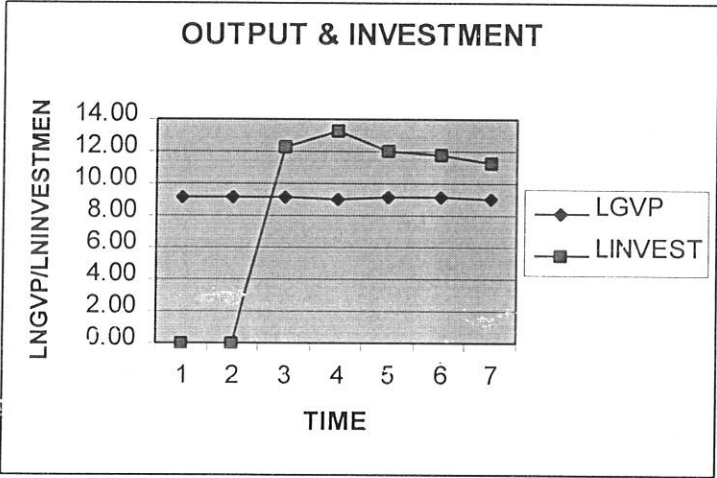


Figure 12: Output & investment for non-metal and wood sector.

From table 5.4, mean TE in the sector is 0.68 which means privatized firms in the sector have the opportunity of increasing their out put level by 0.32 percent without incurring additional costs like new investment. The minimum TE during the period is 0.04 where as the maximum is 0.99

and we can say that there is a wide difference in the level of TE of firms through time. The histogram from figure 13 shows some negative skewness and larger number of firms operate below 0.32 TE level.

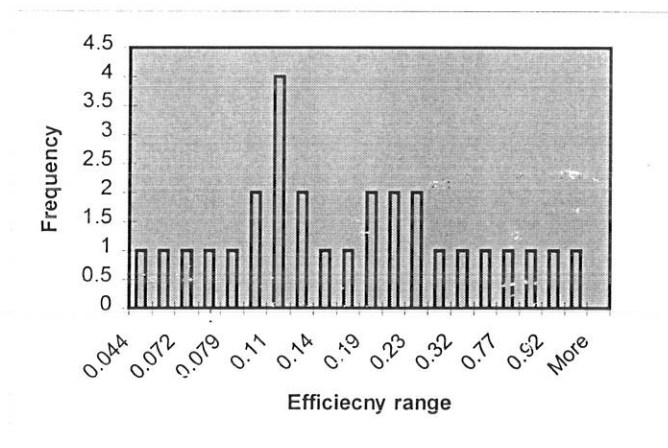


Figure 13: Frequency distribution of TE of firms in non-metal & wood sector for the study period.

5.2.5 TEXTILE AND LEATHER

The appropriate model chosen for textile and leather sector is translog stochastic frontier model with the assumption of truncated normal distribution. From a generalized likelihood ratio test for the factors affecting technical efficiency on table 5.4, the null hypothesis of no age, no time, no ownership and no size effect is rejected at 5% which means that all the variables are significant.

If we look at the sign of age from table 5.2, it is negative and significant which means that as the factory's age increases, efficiency increases. This may be due to the fact that the efficiency gain

due to experience through time is out weighted the efficiency loss due to machine depreciation and out dated technology i.e. firms learn from there past experience and become more efficient than being inefficient due to depreciation and outdated technology.

Time in this model shows the movement of TE of firms during the study period. As the result indicated the sign of the coefficient of time is negative which means there has been improvement in TE of firms through time. From figure 14 below, the general trend shows that there has been improvement in TE efficiency level through time; and this result is consistent with the regression result.

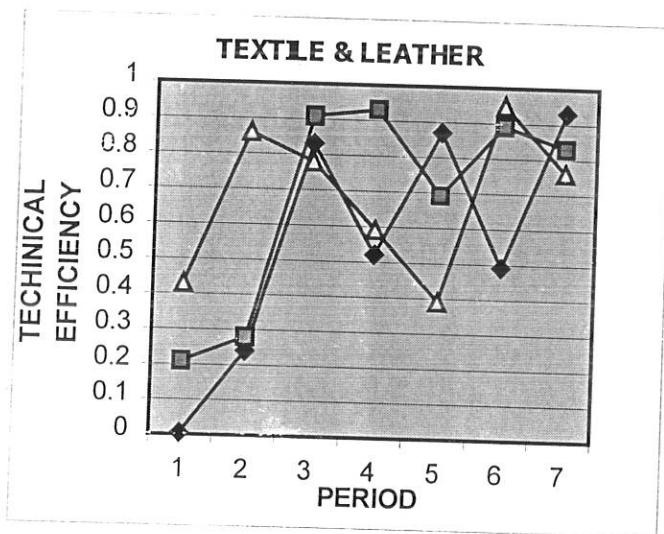


Figure 14: TE of firms in textile & leather sector for the study period.

The sign of ownership dummy from table 5.2 in the inefficiency model is found to be positive which means technical efficiency of firms in textile & leather sector has decreased because of change in ownership from public to private. One of the explanations for this may be the nature of structure of ownership of firms does not allow for competition.

Sixty six point six seven (66.67) percent of textile & leather firms are owned by single owner. This may be due to the fact that the size of firms under this sector is relatively large compared to other sectors and this made them unaffordable to individual domestic investors to participate in the privatization process. There fore like beverage sector, there has been some what semi-monopolistic market structure.

The other reason may be due to the fact that there has been additional capital investment while output was declining after period 4 (change in ownership occur after period 4). According to EPA privatization criteria for textile and leather sector, the buyer is required to make some capital expansion. However if we look at figure 15 below, investment has already been increasing before privatization and started to decline after privatization. The negative effect of change in ownership on TE of firms could be due to the fact that capital that has been invested while firms were under public ownership has not been utilized to produce maximum out put after ownership change (since out put has been declining) and due to criteria put by privatization agency, firms under took investment (even though its growth is smaller than under public ownership) with out maximizing output . There fore instead of producing more output with the available capital, firms have been producing less out put with more capital .

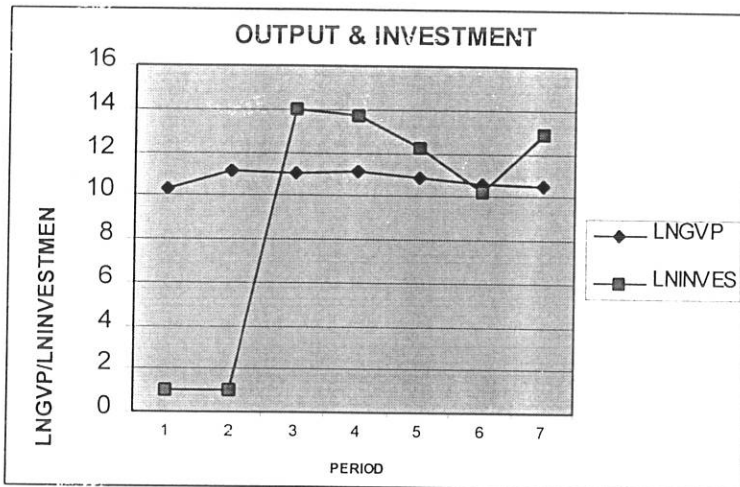


Figure 15: Output & investment for textile & leather sector.

From table 5.2, size is found to have positive sign in the inefficiency model and this means that as the size of a firm increases, TE of a firm decreases. From section 4.2.1, size has been measured by number of persons engaged and therefore negative significant effect of size on TE could indirectly show that there has been a redundancy of labor in textile & leather sector.

The minimum TE level during the period is 0.004 where as the maximum is 0.95 and this shows a wide variation in firms TE level through time. The histogram under figure 16 shows some negative skewness and most of the firms operate below 0.23 TE level. Mean TE is found to be 0.63 which means actual out put level can be increased on average by 0.37 percent without incurring further costs i.e. new investment.

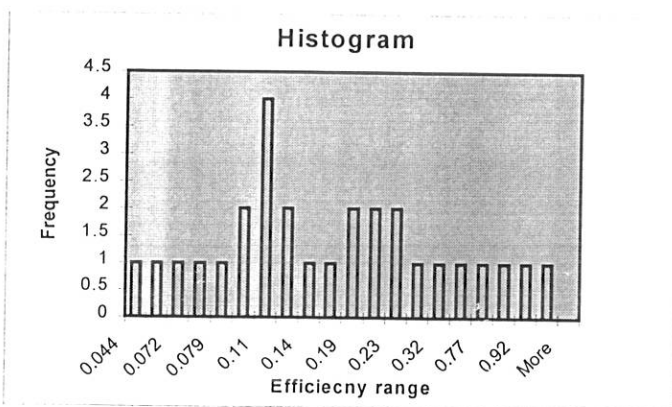


Figure 16: Frequency distribution of TE of firms under textile & leather sector.

CHAPTER SIX

CONCLUSION AND POLICY RECOMMENDATION

6.1 INTRODUCTION

According to the new market strategy, privatization and market orientation have been strongly recommended by organizations like IMF and World Bank. The main arguments for privatization are the efficiency gain due to privatization and minimizing government participation in production. As explained earlier, the main objective of this study is to analyze the impact of privatization on TE of large and medium scale manufacturing firms and to give some policy recommendation. Conclusions and policy recommendations based on the estimated results are presented in the following section.

6.2 CONCLUSION

The result obtained on the impact of privatization on TE of privatized large and medium scale manufacturing industries is mixed. As explained in section 5.2.1, privatization has improved TE of firms under food processing sector where as TE of beverage and textile and leather sector decreased after privatization. TE of chemical and printing and textile and leather has not shown a significant change. It has however been clear that there has been inefficiency in all firms under

all sectors and there is a need to maximize output without absorbing new resources.

For food processing sector, there has been improvement in TE of firms because of competitive behavior existing under the sector and there was no new capital investment criteria to the sector so output has been growing faster than new capital investment.

For beverage the result has indicated that there has been improvement in TE through time and there has been a decline in TE due to ownership change. From these two results one can conclude that in the beverage sector TE has been improving through time due to other policy improvement than privatization. This may be because the semi-monopolistic behavior existing under the sector and new capital expansion criteria set up by EPA .

For textile and leather sector, there has been improvement in TE through time and there has been a decline in TE due to ownership change. From these two results one can conclude that in the sector TE has been improving through time due to other policy improvement than privatization. Privatization has shown negative impact on TE of firms in the sector may be because of the semi-monopolistic behavior existing under the sector and new capital expansion criteria set up by EPA.

In non-metal and wood, and chemical and printing sector firms are owned by different owners and there is a competitive environment. However the impact of privatization on TE of these sectors is not seen.

The results obtained above somehow show that sectors with competitive behavior showed TE improvement whereas those with semi-monopolistic behavior fail to achieve TE gain objective of

privatization. This goes with the theory of privatization as Brabant explained in the article “ the economics of property right and privatization in transational economies” as :

“The success or failure of privatization in achieving efficiency depends critically on the creation of the most essential elements of a competitive environment, including effective control mechanism , and the recognition in principle of the validity of all alternative right.”

Some of the reasons for the existence of this semi-monopolistic behavior are lack of anti-trust laws and policy-related constraints that discourage new entrants. The followings are some of the policy-related issues that hinder the participation of new entrants in the privatization process of Ethiopia:

- Lack of informing the public about what is up for sale ahead of time, say one year in advance.
- High and specific collateral requirement for bank loans.
- The process of compensating ex-owners for nationalized properties is slow and this made the attitudes of especially foreign investors in the area of property right uncertain.
- Lack of technological information and support services and information on export market.
- There is no property right law.
- The size of the market is small i.e. low income and purchasing power limited the absorptive capacities of the domestic market.
- Limited capital base of local entrepreneurs , weak financial market and venture capital .
- The absence of stock market.
- An investor who has bought an enterprise form EPA should negotiate about his land holding arrangement with regional bureaus and this creates uncertainty.

- The number of enterprise offered for privatization at one time is large and this may be more than the absorptive capacity of the domestic market.

Therefore there is a need to consider the above policy-related issues and establish effective antitrust (i.e. competition) laws and post-privatization anti-competitive behavior must be addressed. Unless these conditions are fulfilled, the benefits of privatization would be reduced because there would be little incentive for the companies to maximize efficiency. More generally, anti-competitive behavior damages the very fabric of a developing economy because:

- There is inefficient allocation of scarce resources
- Rigidities are caused which render the economy more vulnerable to external crises
- Economic development is stifled.(Price Waterhouse:1998)

6.3 POLICY RECOMMENDATION

For economic growth of a given country, a policy that could avoid misutilization of resources is a necessity. The danger inherent in privatization programs is the development of excessive concentration of economic power in the hands of a limited number of private participants. This can occur by means of anti-competitive practice by those participants in each sector. The potential for such risk should be detected in advance during preparing and tendering of state owned manufacturing enterprises with respect to their sectors.

As explained in the above section, the anti-competitive behavior existing in the beverage and textile and leather sectors made TE of firms significantly decline after privatization. Therefore addressing ant-trust laws, post-privatization anti-competitive behavior and adjusting the above policy-related issues that hindered the participation of new entrants would make future privatization more successful in achieving TE gain in the manufacturing sector. Before selling of enterprises , it would be more appropriate if first the existing institutional and market capacity is studied.

Moreover, when new investment criteria is set by EPA, the capacity utilization of firms under public ownership should be considered first. Other wise if new investment criteria is set for a firm with already existing capacity under utilization, then the efficiency gain objectives of privatization will not be achieved as it has been seen for beverage and textile & leather sectors.

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APPENDICES

Appendix1: Regression result of the average production function (AF).

Variables	Food	Beverage	Printing & chemical	None Metal and Wood	Textile & leather
	AF	AF	AF	AF	
CONSTANT	0.65 (0.1)	-0.349 (-0.21)	-37.6 (1.90)	2.51 (4.02)	-31.75 (-1.09)
INDUSTRIAL	-0.49	0.24	-0.31	0.42	1.72
COST (IC)	(-0.64)	(2.18)	(-0.37)	(4.09)	(0.57)
LABOR	1.81 (1.69)	1.67 (4.39)	7.51 (2.26)	0.64 (3.8)	4.54 (0.95)
CAPITAL	-0.04	0.15	5.49	-0.048	2.68
	-0.05	(1.11)	(1.88)	(-0.44)	(1.04)
(IC)(LABOR)	-0.11 (-1.19)	-	-0.08 (-0.66)		-0.14 (-0.28)
(IC)(CAPITAL)	0.23 (3.74)	-	0.15 (1.91)		-0.071 (-0.024)
(LABOR)(CAPIT AL)	-0.12 (-0.86)	-	-0.91 (-1.91)		-0.24 (-0.79)
VARIANCE PARAMETER					
$\delta^2 = \delta_v^2 + \delta_u^2$	0.86	0.67	0.53	0.42	1.42
Log-likelihood Function	-90.43	-40.4	-18.8	-25.4	-29.22

Appendix 2: Regression result of stochastic frontier production function with the assumption of half-normal distribution

Variables	Food	Beverage	Printing & chemical	None Metal and Wood	Textile & leather
	SFHN	SFHN	SFHN	SFHN	SFHN
CONSTANT	4.07 (0.9)	2.08 (1.52)	-36.6 (-37.8)	2.4 (4.74)	-30.6 (-30.7)
INDUSTRIAL COST (IC)	-0.40 (-0.84)	0.45 (5.52)	-0.84 (-5.35)	0.40 (4.08)	1.11 (1.46)
LABOR	1.85 (2.4)	0.81 (4.99)	7.60 (34.8)	0.70 (4.19)	6.17 (4.14)
CAPITAL	-0.68 (-1.04)	-0.12 (-1.11)	5.25 (32.6)	-0.12 (-1.06)	2.09 (1.68)
(IC)(LABOR)	-0.13 (-2.19)		-0.08 (-2.14)	-	-0.33 (-1.64)
(IC)(CAPITAL)	0.23 (4.77)	-	0.24 (6.39)	-	0.20 (0.96)
(LABOR)(CAPITAL)	-7.77 (-0.77)	-	-0.90 (-34.2)	-	-0.40 (-4.03)
INEFFICIENCY MODEL					
SIZE	0.0007 (2.13)	0.072 (1.28)	0.09 (2.69)	-0.002 (1.69)	0.02 (1.95)
AGE	0.04 (4.5)	0.17 (2.6)	-0.14 (-8.91)	0.00024 (0.16)	-0.61 (-2.07)
TIME	-0.007 (0.069)	-0.0003 (-1.17)	-0.003 (-0.012)	0.23 (1.32)	0.32 (0.81)
OWNERSHIP DUMMY	-2.52 (-3.30)	-0.98 (-2.43)	3.16 (4.47)	-1.11 (-1.05)	0.47 (0.44)
VARIANCE PARAMETER					
$\delta^2 = \delta_v^2 + \delta_u^2$	0.69	0.75	0.67	0.30	1.74
$\gamma = \delta_u^2 / \delta^2$	0.86	0.67	0.99	0.04	0.95
Log-likelihood Function	-70.6	-30.4	-0.73	-21.9	-20.8
MEAN TE	0.38	0.68	0.67	0.88	0.66

Appendix 3: Regression result of stochastic frontier production function with the assumption of truncated normal distribution.

Variables	Food	Beverage	Printing & chemical	None Metal and Wood	Textile & leather
	SFTN	SFTN	SFTN	SFTN	SFTN
CONSTANT	2.05 (2.37)	6.29 (1.92)	-36.69 (-35.31)	0.39 (0.019)	-30.5 (-20.86)
INDUSTRIAL	0.38 (0.83)	0.53 (4.4)	-0.83 (-5.27)	0.64 (6.72)	0.62 (1.25)
COST (IC)	1.93 (5.16)	0.08 (0.22)	7.61 (35.7)	0.42 (2.53)	8.01 (13.75)
LABOR	-0.64 (1.65)	0.056 (0.52)	5.26 (25.59)	0.0034 (0.026)	0.87 (1.45)
CAPITAL	-0.16 (-2.57)	-	-0.08 (-2.37)	-	-0.51 (5.34)
(IC)(LABOR)	0.16 (3.83)	-	0.24 (6.49)	-	0.46 (6.62)
(IC)(CAPITAL)	-0.047 (-0.69)	-	-0.91 (-17.9)	-	-0.48 (-7.71)
(LABOR)(CAPITAL)					
INEFFICIENCY MODEL					
CONSTANT	1.83 (7.8)	4.24 (4.16)	0.07 (0.07)	4.38 (0.012)	7.97 (3.95)
SIZE	0.0004 (1.43)	-0.014 (-1.61)	0.01 (2.16)	-0.017 (-2.85)	0.007 (1.15)
AGE	0.025 (5.3)	-0.03 (3.08)	-0.15 (-1.88)	-0.045 (-2.95)	-0.42 (-3.01)
TIME	-0.13 (-1.98)	-0.53 (-3.84)	-0.0074 (0.023)	-0.028 (-0.34)	-1.8 (-3.03)
OWNERSHIP	-1.68 (-4.03)	0.34 (0.60)	3.04 (1.58)	0.004 (-0.11)	2.32 (1.15)
DUMMY					
VARIANCE PARAMETER					
$\delta^2 = \delta_v^2 + \delta_u^2$	0.52	0.29	0.67	0.21	2.23
$\gamma = \delta_u^2 / \delta^2$	0.99	0.23	0.99	0.26	0.99
Log-likelihood Function	-62.7	-26.5	0.034	-18.	-10.4
MEAN TE	0.26	0.59	0.68	0.13	0.63

Appendix 4

Maximum likelihood estimation result for trans-log function in the food processing sector

Ols

	coefficient	standard-error	t-ratio
beta 0	0.47785834E+01	0.76794166E+01	0.62225864E+00
beta 1	-0.37612196E+00	0.80523196E+00	-0.46709766E+00
beta 2	0.47871466E+00	0.21091608E+01	0.22696926E+00
beta 3	-0.12119414E+00	0.11627583E+01	-0.10422987E+00
beta 4	-0.29708719E-02	0.43225858E-01	-0.68729044E-01
beta 5	0.16891676E+00	0.18397253E+00	0.91816293E+00
beta 6	0.43137655E-01	0.61993524E-01	0.69584130E+00
beta 7	-0.13728392E+00	0.11863631E+00	-0.11571830E+01
beta 8	0.23904397E+00	0.66995465E-01	0.35680620E+01
beta 9	-0.22908394E+00	0.17837790E+00	-0.12842619E+01
sigma-squared	0.88613927E+00		

log likelihood function = - 89.69

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.86330619E+01	0.60139736E+01	0.14355005E+01
beta 1	0.62142768E+00	0.57018244E+00	0.10898752E+01
beta 2	-0.16620083E+01	0.19038092E+01	-0.87299102E+00
beta 3	0.91455869E-01	0.88554292E+00	0.10327661E+00
beta 4	-0.23754687E-02	0.32202357E-01	-0.73766918E-01
beta 5	0.22610858E+00	0.15922134E+00	0.14200897E+01
beta 6	-0.36254216E-01	0.55572692E-01	-0.65237465E+00
beta 7	-0.15670766E+00	0.89952875E-01	-0.17421084E+01
beta 8	0.13057793E+00	0.49645795E-01	0.26301912E+01
beta 9	0.97301196E-02	0.13337781E+00	0.72951561E-01
sigma-squared	0.53499757E+00	0.12573685E+00	0.42548988E+01
gamma	0.80763001E+00	0.17953515E+00	0.44984507E+01
delta 0	0.21285868E+01	0.68566532E+00	0.31044108E+01
delta 1	-0.67317177E-03	0.15875326E-02	-0.42403649E+00
delta 2	0.88356720E-02	0.23341745E-01	0.37853519E+00
delta 3	0.38244308E-04	0.47903633E-04	0.79835924E+00
delta 4	-0.32074882E+00	0.75789855E-01	-0.42320812E+01
delta 5	-0.64138107E+00	0.33123571E+00	-0.35401279E+01

log likelihood function = -71.08

Appendix 5

Maximum likelihood estimation for Cobb-Douglas production function in the food processing sector

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.36879924E+00	0.12750116E+01	0.28925167E+00
beta 1	0.45605555E+00	0.75980715E-01	0.60022540E+01
beta 2	0.18094091E+00	0.17198784E+00	0.10520565E+01
beta 3	0.57303658E+00	0.97011034E-01	0.59069216E+01
sigma-squared	0.10117319E+01		

log likelihood function -88.012

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.28005307E+01	0.10184999E+01	0.27496623E+01
beta 1	0.54168587E+00	0.68810672E-01	0.78721201E+01
beta 2	0.37071221E+00	0.11722021E+00	0.31625281E+01
beta 3	0.27102426E+00	0.88707508E-01	0.30552572E+01
sigma-squared	0.56645116E+00	0.12449952E+00	0.45498261E+01
gamma	0.99999999E+00	0.22362368E-03	0.44717982E+04
delta 0	0.17948470E+01	0.67117920E+00	0.26741695E+01
delta 1	0.93107546E-03	0.11736394E-02	0.79332326E+00
delta 2	0.33710733E-01	0.16203795E-01	0.20804221E+01
delta 3	-0.12518916E-04	0.33817052E-04	-0.37019535E+00
delta 4	-0.23424236E+00	0.74443324E-01	-0.31465866E+01
delta 5	-0.84138107E+00	0.33123571E+00	-0.25401279E+01

log likelihood function -70.8611

Appendix 6

Maximum likelihood estimation for Cobb-Douglas production function in the beverage sector

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.44948143E+01	0.69934009E+00	0.64272223E+01
beta 1	0.51026563E+00	0.16468494E+00	0.30984352E+01
beta 2	0.40526901E+00	0.22157442E+00	0.18290424E+01
beta 3	-0.70723328E-01	0.14024937E+00	-0.50426841E+00
sigma-squared	0.65586259E+00		

log likelihood function -28.88

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.31360695E+01	0.23650383E+00	0.13260121E+02
beta 1	0.10081808E+01	0.86038256E-03	0.11717820E+04
beta 2	-0.15868933E+00	0.63557606E-01	-0.24967795E+01
beta 3	0.21387232E+00	0.31506155E-01	0.67882710E+01
sigma-squared	0.91278216E+00	0.14958935E+00	0.61019192E+01
gamma	0.99999999E+00	0.76584352E-07	0.13057497E+08
delta 0	0.28802609E+00	0.95703348E+00	0.30095717E+00
delta 1	-0.37483815E-02	0.24642950E-01	-0.15210766E+00
delta 2	0.15533236E+00	0.28917051E-01	0.53716530E+01
delta 3	-0.14963898E+00	0.39268162E-01	-0.38106949E+01
delta 4	-0.26186127E-01	0.15106046E-01	-0.17334865E+01
delta 5	0.17714263E-02	0.83739700E-03	0.21153960E+01

log likelihood function -15.13

Appendix 7

Maximum likelihood estimation for trans-log production function in the beverage sector

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.87764264E+01	0.53587547E+01	0.16377735E+01
beta 1	0.29780065E+01	0.14260006E+01	0.20883627E+01
beta 2	-0.23243577E+01	0.19321349E+01	-0.12029997E+01
beta 3	-0.75661502E+00	0.10301208E+01	-0.73449153E+00
beta 4	0.20112676E+00	0.17449711E+00	0.11526080E+01
beta 5	0.93531556E-01	0.37632092E+00	0.24854201E+00
beta 6	0.16905993E-01	0.15500777E+00	0.10906546E+00
beta 7	-0.29235724E+00	0.46641242E+00	-0.62682131E+00
beta 8	-0.35885224E+00	0.21421855E+00	-0.16751689E+01
beta 9	0.39156732E+00	0.35076550E+00	0.11163222E+01
sigma-squared	0.67236874E+00		

log likelihood function = -36.82

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.92054506E+01	0.96800121E+00	0.95097512E+01
beta 1	0.27542197E+01	0.33402305E+00	0.82455977E+01
beta 2	-0.23755890E+01	0.65050677E+00	-0.36519051E+01
beta 3	-0.54195247E+00	0.45019816E+00	-0.12038087E+01
beta 4	-0.11223250E+00	0.55043911E-01	-0.20389630E+01
beta 5	0.18282322E+00	0.17118880E+00	0.10679625E+01
beta 6	0.14372346E+00	0.93426093E-01	0.15383653E+01
beta 7	0.12189798E+00	0.14814270E+00	0.82284163E+00
beta 8	-0.11214989E+00	0.18573546E-01	-0.60381518E+01
beta 9	-0.15878076E+00	0.19578413E+00	-0.81099912E+00
sigma-squared	0.69247023E+00	0.11814832E+00	0.58610249E+01
gamma	0.99999999E+00	0.60374379E-07	0.16563317E+08
delta 0	0.23751368E+01	0.10301374E+01	0.23056505E+01
delta 1	0.50299192E-01	0.47392270E-01	0.10613375E+01
delta 2	0.98627111E-03	0.15652150E-02	0.63011863E+00
delta 3	-0.10365787E-03	0.73021864E-04	-0.14195457E+01
delta 4	-0.44467083E+00	0.21369519E+00	-0.20808650E+01
delta 5	0.28238245E+01	0.88838397E+00	0.31786081E+01

log likelihood function = -15.00

Appendix 8

Maximum likelihood estimation for trans-log production function in non-metal and wood sector

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.56371092E+01	0.29985591E+01	0.18799394E+01
beta 1	0.29836939E+01	0.18637613E+01	0.16008992E+01
beta 2	0.26531962E+00	0.27806395E+01	0.95416763E-01
beta 3	-0.34129340E+01	0.26717119E+01	-0.12774334E+01
beta 4	-0.76121895E-01	0.91507817E-01	-0.83186222E+00
beta 5	0.43067598E-01	0.34671234E+00	0.12421709E+00
beta 6	0.83272091E-01	0.12372121E+00	0.67306235E+00
beta 7	-0.25812337E+00	0.18916598E+00	-0.13645338E+01
beta 8	0.68118604E-01	0.97775811E-01	0.69668156E+00
beta 9	0.23378750E+00	0.25474235E+00	0.91774102E+00
sigma-squared	0.38837506E+00		

log likelihood function -20.3

the estimates after the grid search were :

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.44586011E+01	0.48493043E+00	0.91943107E+01
beta 1	0.29941689E+01	0.25066798E+00	0.11944760E+02
beta 2	0.11866966E+01	0.37077478E+00	0.32005861E+01
beta 3	-0.30639990E+01	0.51050644E+00	-0.60018813E+01
beta 4	-0.17250895E+00	0.19482536E-01	-0.88545431E+01
beta 5	-0.23530803E+00	0.72888948E-01	-0.32283087E+01
beta 6	0.53617877E-01	0.48405846E-01	0.11076736E+01
beta 7	0.24132176E-01	0.55427263E-01	0.43538459E+00
beta 8	0.42785381E-02	0.36724536E-01	0.11650353E+00
beta 9	0.29721901E+00	0.12444779E+00	0.23883029E+01
sigma-squared	0.16093716E+00	0.35564782E-01	0.45251833E+01
gamma	0.99999999E+00	0.28238946E-07	0.35412086E+08
delta 0	-0.48016815E+00	0.10699409E+01	-0.44878007E+00
delta 1	0.13927075E-01	0.35242325E-02	0.39518037E+01
delta 2	0.87617684E-01	0.35664880E-01	0.24566937E+01
delta 3	-0.58204040E-03	0.12610943E-03	-0.46153600E+01
delta 4	0.12639833E+00	0.76682493E-01	0.16483336E+01
delta 5	-0.72237018E+00	0.39427921E+00	-0.18321285E+01

log likelihood function -38.13

Appendix 9

Maximum likelihood estimation for Cobb-Douglas production function in the non-metal and wood sector

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.21544849E+01	0.53650506E+00	0.40157774E+01
beta 1	0.41818527E+00	0.10219246E+00	0.40921342E+01
beta 2	0.63664984E+00	0.16785817E+00	0.37927845E+01
beta 3	-0.48288895E-01	0.10910163E+00	-0.44260470E+00
sigma-squared	0.42167356E+00		

log likelihood function -47.41

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.17782655E+01	0.26932522E+00	0.66026699E+01
beta 1	0.10261475E+01	0.92192104E-01	0.11130536E+02
beta 2	0.10912861E+00	0.95813862E-01	0.11389647E+01
beta 3	0.15385958E+00	0.84592759E-01	0.18188268E+01
sigma-squared	0.23382229E+00	0.76797779E-01	0.30446491E+01
gamma	0.99999999E+00	0.79400142E-01	0.12594436E+02
delta 0	-0.16795276E+00	0.99508066E+00	-0.16878306E+00
delta 1	0.15047742E-01	0.30751108E-02	0.48933981E+01
delta 2	0.96200726E-01	0.35000312E-01	0.27485677E+01
delta 3	-0.60226795E-03	0.10393786E-03	-0.57945001E+01
delta 4	-0.80886018E-02	0.11867036E+00	-0.68160255E-01
delta 5	0.16001605E+00	0.51200369E+00	0.31252910E+00

log likelihood function -39.94

Appendix 10

Maximum likelihood result for printing and chemical sector with trans-log frontier production model

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.10949157E+02	0.30500024E+02	-0.35898848E+00
beta 1	0.35239200E+00	0.11512488E+01	0.30609543E+00
beta 2	0.14378915E+00	0.80842478E+01	0.17786336E-01
beta 3	0.36269598E+01	0.32077200E+01	0.11306971E+01
beta 4	0.80377801E-01	0.53662520E-01	0.14978387E+01
beta 5	0.84644649E+00	0.77072108E+00	0.10982527E+01
beta 6	0.13994181E+00	0.21562457E+00	0.64900680E+00
beta 7	-0.44945137E+00	0.29277963E+00	-0.15351183E+01
beta 8	0.25147137E+00	0.12202971E+00	0.20607389E+01
beta 9	-0.10359806E+01	0.71089383E+00	-0.14572930E+01
sigma-squared	0.54993325E+00		

log likelihood function -19.65

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.10073809E+02	0.10207128E+01	-0.98693868E+01
beta 1	0.50153026E+00	0.27287191E+00	0.18379696E+01
beta 2	0.18605132E+00	0.74556311E+00	0.24954469E+00
beta 3	0.29512976E+01	0.54967090E+00	0.53692083E+01
beta 4	0.43850307E-01	0.54689223E-02	0.80180892E+01
beta 5	0.56627367E+00	0.30213547E+00	0.18742376E+01
beta 6	0.18749773E-01	0.11684227E+00	0.16047080E+00
beta 7	-0.40960161E+00	0.93165699E-01	-0.43964851E+01
beta 8	0.27131353E+00	0.61324678E-01	0.44242145E+01
beta 9	-0.59124665E+00	0.38150762E+00	-0.15497637E+01
sigma-squared	0.24313201E+00	0.66997233E-01	0.36289859E+01
gamma	0.99999999E+00	0.37819106E-07	0.26441661E+08
delta 0	0.10445726E+01	0.11864232E+01	0.88043844E+00
delta 1	0.16315632E-02	0.75732831E-02	0.21543670E+00
delta 2	-0.11041945E+00	0.37301359E-01	-0.29601992E+01
delta 3	0.23261482E-03	0.39939323E-03	0.58242052E+00
delta 4	-0.29146916E+00	0.29435258E+00	-0.99020423E+00
delta 5	0.42670489E+01	0.10404750E+01	0.41010586E+01

log likelihood function -0.82

Appendix 11

Maximum likelihood estimation result in chemical & printing sector with Cobb-Douglas frontier production model

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.19194944E+01	0.16383415E+01	-0.11716082E+01
beta 1	0.24361375E+00	0.81905241E-01	0.29743366E+01
beta 2	0.11790518E+01	0.32477645E+00	0.36303487E+01
beta 3	0.29001308E+00	0.14343083E+00	0.20219717E+01
sigma-squared	0.57576691E+00		

log likelihood function -21.87

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.34641000E+01	0.13668572E+01	-0.25343541E+01
beta 1	0.20006721E+00	0.47765924E-01	0.41884924E+01
beta 2	0.15119443E+01	0.75879574E-01	0.19925578E+02
beta 3	0.37629319E+00	0.15527664E+00	0.24233727E+01
sigma-squared	0.10886887E+01	0.38638913E+00	0.28175965E+01
gamma	0.99999999E+00	0.12918578E+00	0.77407902E+01
delta 0	0.14691740E+00	0.99903633E+00	0.14705911E+00
delta 1	0.95502419E-02	0.99131871E-02	0.96338763E+00
delta 2	-0.21830865E-01	0.30765108E-01	-0.70959821E+00
delta 3	0.97058517E-04	0.51854376E-03	0.18717517E+00
delta 4	-0.33416769E+00	0.31825227E+00	-0.10500088E+01
delta 5	0.12396480E+01	0.95100523E+00	0.13035133E+01

log likelihood function -15.545

Appendix 12

Maximum likelihood estimation for a trans-log production function in textile & leather sectors

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.86706858E+01	0.42605681E+01	-0.20351009E+01
beta 1	-0.10784430E+01	0.55361558E+00	-0.19479997E+01
beta 2	0.82372943E+00	0.15972909E+01	0.51570409E+00
beta 3	0.37706602E+01	0.18252819E+01	0.20657961E+01
beta 4	0.14522869E-01	0.60705426E-01	0.23923510E+00
beta 5	0.53569556E+00	0.42481837E+00	0.12609991E+01
beta 6	-0.20802016E-01	0.17498996E+00	-0.11887548E+00
beta 7	-0.32494776E+00	0.32122713E+00	-0.10115826E+01
beta 8	0.46997076E+00	0.31796753E+00	0.14780464E+01
beta 9	-0.80861618E+00	0.49542822E+00	-0.16321561E+01
sigma-squared	0.79420227E+00		

log likelihood function -113.43

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	-0.63466150E+01	0.91763403E+00	-0.69162812E+01
beta 1	-0.99908038E+00	0.16767456E+00	-0.59584495E+01
beta 2	0.25365829E+01	0.60198113E+00	0.42137250E+01
beta 3	0.15610279E+01	0.56748685E+00	0.27507736E+01
beta 4	-0.78813266E-02	0.21028228E-01	-0.37479746E+00
beta 5	0.13016939E+00	0.15443661E+00	0.84286613E+00
beta 6	-0.75711521E-01	0.56628867E-01	-0.13369775E+01
beta 7	-0.24501824E+00	0.11207445E+00	-0.21862097E+01
beta 8	0.42822831E+00	0.10517809E+00	0.40714592E+01
beta 9	-0.34373279E+00	0.17272121E+00	-0.19901018E+01
sigma-squared	0.10222714E+01	0.24035164E+00	0.42532326E+01
gamma	0.96160043E+00	0.24287092E-01	0.39593065E+02
delta 0	0.29914397E+01	0.22684310E+01	0.13187263E+01
delta 1	0.15276487E-01	0.42452390E-02	0.35984987E+01
delta 2	-0.19424588E+00	0.15408141E+00	-0.12606705E+01
delta 3	-0.45468395E-03	0.19554418E-03	-0.23252237E+01
delta 4	-0.11207658E+01	0.24869510E+00	-0.45065859E+01
delta 5	0.37570663E+01	0.10355245E+01	0.36281771E+01

log likelihood function = -0.94638113E+01

Appendix 13

Maximum likelihood estimation for Cobb-douglas production function in textile and leather sectors

the ols estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.38624731E+01	0.81661885E+00	0.47298359E+01
beta 1	0.20860961E+00	0.13461555E+00	0.15496694E+01
beta 2	0.45148747E+00	0.26696571E+00	0.16911815E+01
beta 3	0.17758456E+00	0.22858611E+00	0.77688254E+00
sigma-squared	0.11012712E+01		

log likelihood function -121.23

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.54988000E+01	0.75568713E+00	0.72765564E+01
beta 1	0.48728823E+00	0.11395230E+00	0.42762475E+01
beta 2	-0.46952084E-01	0.17492994E+00	-0.26840508E+00
beta 3	0.32356495E+00	0.10609443E+00	0.30497827E+01
sigma-squared	0.80150308E+00	0.33292910E+00	0.24074287E+01
gamma	0.89385301E+00	0.68644263E-01	0.13021525E+02
delta 0	-0.21101101E+01	0.29305284E+01	-0.72004424E+00
delta 1	0.18303574E-01	0.77657813E-02	0.23569521E+01
delta 2	0.14290234E+00	0.88415372E-01	0.16162612E+01
delta 3	-0.82216096E-03	0.22375681E-03	-0.36743506E+01
delta 4	-0.47543767E+00	0.27026639E+00	-0.17591446E+01
delta 5	0.22267596E+01	0.12998251E+01	0.17131225E+01

log likelihood function -106.94

Appendix 14

Correlation among variables in the food processing sector for the trans-log stochastic frontier model.

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Column 1	1									
Column 2	0.59455	1								
Column 3	0.274743	0.271171	1							
Column 4	0.560972	0.153911	0.111508	1						
Column 5	0.5932	0.990855	0.259602	0.147275	1					
Column 6	0.268425	0.269683	0.996911	0.093533	0.258942	1				
Column 7	0.546188	0.12996	0.092934	0.994693	0.12413	0.075746	1			
Column 8	0.595442	0.936131	0.580786	0.174028	0.929835	0.581194	0.147653	1		
Column 9	0.777505	0.860915	0.276129	0.620224	0.856412	0.26772	0.598726	0.826567	1	
Column 10	0.598433	0.275538	0.595192	0.860587	0.265355	0.581986	0.849742	0.448561	0.653862	1

Column 1 = Logarithm of gross value of output

Column 2 = Logarithm of industrial cost

Column 3 = Logarithm of labor

Column 4 = Logarithm of fixed asset

Column 5 = The square of logarithm of industrial cost square

Column 6 = The square of logarithm of labor

Column 7 = The square of logarithm of fixed asset

Column 8 = Logarithm of industrial cost times logarithm of labor

Column 9 = Logarithm of industrial cost times logarithm of fixed asset

Column 10 = Logarithm of labor times fixed asset

Appendix 15

Correlation among variables in the beverage sector with Cobb-Douglas stochastic frontier model

	<i>Column 1</i>	<i>Column 2</i>	<i>Column 3</i>	<i>Column 4</i>
Column 1	1			
Column 2	0.588289	1		
Column 3	0.773884	0.520231	1	
Column 4	0.386005	0.116742	0.388165	1

Column 1 = Logarithm of gross value of output

Column 2 = Logarithm of industrial cost

Column 3 = Logarithm of labor

Column 4 = Logarithm of fixed asset

Appendix 16

Correlation among the variables in non-metal & wood sector with Cobb-Douglas stochastic frontier model

	<i>Column 1</i>	<i>Column 2</i>	<i>Column 3</i>	<i>Column 4</i>
Column 1	1			
Column 2	0.967407	1		
Column 3	0.965843	0.942619	1	
Column 4	0.94464	0.929298	0.987184	1

Colmn 1 = Logarithm of gross value of output

Colmn 2 = Logarithm of industrial cost

Colmn 3 = Logarithm of labor

Colmn 4 = Logarithm of fixed asset

Appendix 17

Correlation among the variables in chemical & printing sector with trans-log stochastic frontier model

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Column 1	1									
Column 2	0.559963	1								
Column 3	0.809107	0.382942	1							
Column 4	0.458831	-0.14393	0.446272	1						
Column 5	0.554583	0.985595	0.36729	-0.16573	1					
Column 6	0.805533	0.385555	0.998606	0.437513	0.369631	1				
Column 7	0.420599	-0.17918	0.414894	0.997554	-0.19885	0.405265	1			
Column 8	0.672104	0.975752	0.562076	-0.04574	0.96634	0.56681	-0.08396	1		
Column 9	0.745321	0.89831	0.557258	0.279976	0.868401	0.556493	0.243259	0.918769	1	
Column 10	0.745321	0.89831	0.557258	0.279976	0.868401	0.556493	0.243259	0.918769	1	1

Column 1 = Logarithm of gross value of output

Column 2 = Logarithm of industrial cost

Column 3 = Logarithm of labor

Column 4 = Logarithm of fixed asset

Column 5 = The square of logarithm of industrial cost square

Column 6 = The square of logarithm of labor

Column 7 = The square of logarithm of fixed asset

Column 8 = Logarithm of industrial cost times logarithm of labor

Column 9 = Logarithm of industrial cost times logarithm of fixed asset

Column 10 = Logarithm of labor times fixed asset

Appendix 18

Correlation among the variables in textile & leather sector with trans-log stochastic frontier model

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Column 1	1									
Column 2	0.911862	1								
Column 3	0.933284	0.934267	1							
Column 4	0.91049	0.902334	0.955521	1						
Column 5	0.90354	0.998267	0.938048	0.900392	1					
Column 6	0.924545	0.949211	0.993096	0.948954	0.965678	1				
Column 7	0.900592	0.919666	0.957467	0.992632	0.930897	0.963107	1			
Column 8	0.922625	0.979268	0.970426	0.931811	0.95335	0.94885	0.954255	1		
Column 9	0.918329	0.977701	0.964016	0.951199	0.968942	0.982219	0.972718	0.95956	1	
Column 10	0.92116	0.945113	0.986395	0.976489	0.959343	0.93929	0.968816	0.938254	0.987272	1

- Column 1 = Logarithm of gross value of output
Column 2 = Logarithm of industrial cost
Column 3 = Logarithm of labor
Column 4 = Logarithm of fixed asset
Column 5 = The square of logarithm of industrial cost square
Column 6 = The square of logarithm of labor
Column 7 = The square of logarithm of fixed asset
Column 8 = Logarithm of industrial cost times logarithm of labor
Column 9 = Logarithm of industrial cost times logarithm of fixed asset
Column 10 = Logarithm of labor times fixed asset

Appendix 19

FOOD

TE	FREQUENC Y.
----	----------------

0.11	5
0.12	1
0.13	1
0.14	1
0.15	4
0.17	1
0.18	1
0.22	1
0.25	1
0.26	1
0.27	1
0.28	2
0.30	1
0.34	1
0.39	2
0.45	1
0.46	1
0.47	1
0.48	1
0.50	1
0.51	1
0.53	1
0.54	1
0.57	2
0.59	1
0.60	1
0.62	1
0.70	1
0.75	1
0.76	1
0.78	1
0.86	1
0.88	1
0.89	1
0.99	3

NON-METAL AND WOOD

TE	FREQUENCY.
----	------------

0.11	4
0.12	2
0.14	1
0.18	1
0.19	2
0.21	2
0.23	2
0.24	1
0.32	1
0.76	1
0.77	1
0.78	1
0.92	1
0.99	1

BEVERAGE		PRINTING & CHEMICAL		TEXTILE & LEATHER	
TE	FREQUENC Y.	TE	FREQUENCY.	TE	
0.15	2	0.1	1	0.21	
0.17	1	0.27	1	0.24	
0.19	1	0.33	1	0.28	
0.22	1	0.39	1	0.39	
0.24	1	0.51	1	0.43	
0.3	1	0.58	1	0.49	
0.31	1	0.61	1	0.52	
0.33	1	0.62	1	0.59	
0.47	1	0.66	1	0.69	
0.5	1	0.69	1	0.76	
0.53	2	0.7	1	0.78	
0.55	1	0.83	1	0.83	
0.72	1	0.84	1	0.86	
0.73	1	0.86	1	0.87	
0.77	1	0.89	2	0.89	
0.79	1	0.95	1	0.91	
0.83	1	0.96	1	0.95	
0.87	1	0.97	2		
0.89	3	0.99	1		
0.92	2				
0.93	1				
0.95	1				
0.96	3				
0.97	2				

DECLARATION

I the undersigned, declare that this thesis is my own original work and has not been presented in any University . All sources of materials for this thesis have been fully acknowledged.

Name: Rebeka Kebede Hagos

Signature: 

Date :

Place : Addis Ababa