Estimating the Overall Revenue, Technical and Allocative Efficiencies of Ethiopian Commodity Exchange (ECX) Authority.

A Research Paper presented by:

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(Ethiopia)

In partial fulfilment of the requirements for obtaining the degree of

MASTER OF ARTS IN DEVELOPMENT STUDIES

Major: Economics of Development (ECD)

Members of the Examining Committee:

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The Hague, The Netherlands

December 2014

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Acknowledgement

Above all I would like to thank the almighty God, then my best gratitude goes to my Supervisor Professor Mansoob Murshed and co-supervisor Professor Peter van Bergeijk for being provided me a valuable comments and guidance, beginning from the draft of the proposal to the completion of the this paper. In addition, I would like to offer my special thank for Netherland Government for giving me a chance to attend this MA program. Lastly, my appreciation extends to all ISS Fellows and ISS staffs for their friendly support throughout my study period.

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List of Acronyms

ACE	African Commodity Exchange
AE	Allocative efficiency
CBOT	Chicago Board of Trade
CE	Cost Efficiency
CME	Chicago Mercantile Exchange
CRS_TE	Constant Returns To Scale Technical Efficiency
DC	Central Depository
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
DRS	Decreasing Returns to Scale
EAMC	Ethiopian Agricultural Marketing Corporation
ECSA	Ethiopian Central Statistical Agency
ECX	Ethiopia Commodity Exchange
EGC	Ethiopian Grain Corporation
IRS	Increasing Returns to Scale
KLEMS	Capital, Labor, energy, Material Used and Purchased Services
LR	Likelihood Ratio
MLSM	Modified Least Square Methods
MoARD	Ministry of Agriculture and Rural Development
Mu	Mean Inefficiency
OM	Other Material
SE	Scale Efficiency
SFA	Stochastic Frontier Analysis
SFPF	The Stochastic Frontier Production Function
TE	Technical efficiency
TFP	Total Factor Productivity
TOCOM	Tokyo Commodity Exchange
TOPS	Technically Optimal Productive Scale
VRS_TE	Variable returns to scale Technical Efficiency

Abstract

This study estimates the mean Overall Revenue, Technical and Allocative Efficiencies of Ethiopian Commodity Exchange (ECX) market for the seventeen locations from 2009 to 2013 and also identifies the significant inefficiency effects (determinants) of an ECX transaction process. Moreover, this paper compares the technical efficiency of the two famous firms' efficiency analyzing models: the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). All input expenditure data and output exchanged through ECX trading channel over the range of the study period have used for estimating all the above efficiency scores. The whole inputs expenditures have categorized as Labor, Depreciation Expense (Capital Used), Warehouse and Office Rent and Other Material cost nominated as "others". The major commodities considered as an output-indicators are Coffee, Pea Bean and Sesame constitutes more than 99 % of the agricultural commodity exchanged on the ECX trading floor, which are traded for export market that could be the foreign currency source for the country. The aggregated value of the daily exchanged quantities of each commodity multiplied by their corresponding daily prices has used as a proxy of output indicator for both SFA and DEA models efficiency score estimations. Therefore Output-oriented Revenue Function is the best fit equation for this data set and the Constant Returns to Scale (CRS_TE) estimated in the DEA model is considered as Overall Revenue Efficiency of the ECX. Using a DEA model, the mean Overall Revenue, Technical, and Allocative efficiency scores estimated for seventeen DMUs for the last five years are 0.60, 0.63 and 0.95 respectively. Alternatively, the mean Technical Efficiency score estimated using Stochastic Frontier Analysis (SFA) model is 0.81. The DEA model revealed that only two independent variables nominated as "*ASSYIN"* and "*LLRC"* are significantly affecting the Overall Revenue Efficiency of the ECX market.

Relevance to Development Studies

The Ethiopian economy is highly dependent on the agricultural sector and this sector contributes the largest share of the country's GDP (World Bank 2014). The total population of the country is about 79.22 Million, out of this population, 83 present of the citizens are living in the rural area of the country (ECSA 2007). Such a large proportion of rural households are living in subsistence income earned from the agricultural sector. This is because of lower agricultural labor productivity, primitive agricultural technology and lack of market access. The state is intensively working on the response to these constraints. The establishment of the Ethiopian commodity Exchange (ECX) is an institutional response for creating trustful, ordered, and integrated marketing access for agricultural commodities (Gabre-Madhin 2001). ECX is mainly focusing on exchanging major agricultural crops like Coffee, Pea Bean, Sesame, Mung Bean, Wheat, and Maize from which most of the population of the country can be benefited at large. Creating efficient market access for these agricultural commodities are crucial to the country's economy and has great contribution to poverty reduction. Essentially the first three commodities are exportable agricultural commodities and ECX is the only authorized market place for exporting these agricultural commodities. The value of these commodities exchanged at ECX trading floor is exactly equal to the country's foreign currency earned from these three commodities. Hence improving the operational efficiency of ECX to boost the inflow of agricultural commodities to ECX marketing channel has dual country's economic advantage. On one hand, it used to raise the producer's income by improving on-farm productivity as backward linkage (Kamara 2004). In the other hand, it used to contribute for enhancing the country's revenue earning from the export market as forward linkage.

Key Words : Ethiopian Commodity Exchange (ECX), Revenue efficiency,Technical efficiency, Allocative efficiency, DEA Model and SFA Model.

Chapter one: Introduction

1.1 Background Of The Study.

Launching Commodity Exchange institutions had an ancient history of the current industrialized countries, for instance USA had established the former Chicago Board of Trade (CBOT) in 1848 and it is the oldest exchange place in the world. In 2007, the CBOT had unified with other enterprises to form Chicago Mercantile Exchange (CME) group[1]. This CME group currently facilitates the exchange of agricultural commodities, electronics, energy, real state and so on. The Great Britain had also established London Metal Exchange in 1877 for exchanging various metals[2]. Similarly, Japan had established its Tokyo textile and rubber exchange market in 1951 and 1952 respectively. These separate exchange markets had unified to form Tokyo Commodity Exchange (TOCOM) in 1984. TOCOM had been used to exchange rubber, gold and platinum, but latter TOCOM has diversified more to electronics, aluminum, oils and gasoline exchanges[3]. For the developing countries, the use of commodity exchange has thriven accompanied with the liberalization reforms in 1990's. The Latin and Asian countries have launched their commodity exchange immediately after the 1990's liberalization reform, but some African countries were lately commenced such institutions just after 2005. Today there is a boom of interest in developing countries to put the right institutions in place such as Commodity Exchanges particularly for primary agricultural commodities that helps not only to modernize the trading system but also benefits the country's economy and private traders as well. In addition, it helps donor organizations to minimize the transaction cost and also used for producers' as a potential tool for risk management (Rashid et al. 2010). It is about only two decades that Ethiopia has undergone a meaning full market reform by eliminating all kinds of market restrictions and liberalizing the market. Before the reform has been implemented in 1990, Ethiopia has been controlling grain movement, even across the regions of the same country for about 15 years, even after the market reform have been introduced in the country, only 18 percent of grain pass through the formal market channel from the total surplus grain produced for the market (Lirenso 1993). This conveys the message that the produced grain are not delivered to the market through regular market channel, therefore it requires establishing the new institute to facilitate the grain trade, thereby raising the delivery of agricultural commodities to the formal market chain that helps to stabilize the commodity price and minimize the transaction cost simultaneously (Gabre-Madhin 2001).

Free market reform *per-se* doesn't increase the volume of grain provided to the market as it was a policy reform, but not an achievement of linking the buyers and sellers together that used to increase competition and stabilize the market price, therefore the grain market continued as a thin and fragmented market where there were a limited number of market actors as buyers and sellers (Gabre-Madhin and Goggin 2005). In addition to great desire of the state to attract large volume of grain, the fundamental motives for the establishment of the commodity exchanges in developing countries are: i) higher price of agricultural commodities due to high transaction cost, ii) the need of standardized and graded agricultural products, iii) an inclined interest on market information, iv) great interest for financial market to respond to huge commodity market and, v) high interest for transferring risk

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[1] http://www.cmegroup.com/company/history/
[2] https://www.lme.com/about-us/history/
[3] http://www.tocom.or.jp/profile/history.html

through contract and warehouse receipts (Gabre-Madhin 2006). Therefore the Ethiopian Commodity Exchange (ECX) has been established in March 2008 beside the former market policy reform in 1990s' to fill the marketing gap with a primary vision of transforming the traditional agricultural marketing system to the kind of market facilitating institution, which is modern, reliable, competitive, governed by rules and regulation to serve all market actors such as small scale farmers, large scale state-farms, trade unions, private traders, local processors, agricultural commodity exporters and consumers impartially. The ECX is a key interventions and modern appropriate market facilitating institution to bring buyers and sellers together that improve the role of the agricultural commodity market for the growth of economic development and improves the performance of the grain market by minimizing the transaction cost that spent for brokers and intermediaries in order to join the buyers and sellers in the trading process. In order to achieve these objectives, establishing the market facilitating institution like Ethiopian Commodity Exchange (ECX) is quite necessary but not sufficient condition. These institutions need to be efficiently served the market actors, thereby effectively attract large volume of agricultural commodities to this channel that improve the country's foreign currency earned from agricultural commodity export.

Based on the profile of the Ethiopian Commodity Exchange (ECX), it engaged in facilitating the transaction process of six agricultural commodities such as Coffee, Sesame, Pea Bean, Mung Bean, Maize and Wheat. Of these selected agricultural commodities, the first three are traded for the export market and constitutes more than 99 % of the total commodities traded on the ECX trading floor. ECX is the only market channel through which these commodities are traded for export market. Since ECX trading floor is the only authorized marketplace for exporting Coffee, Pea Bean, Sesame, an efficient operation of the ECX in terms of delivering, storing, weighing, grading, labeling, exchanging and ownership transferring is crucial to attracting large volume of agricultural commodities and producers that helps to improve the country's revenue of foreign currency. In addition, identifying and removing the major causes of inefficiency in terms of managerial aspects, determinant rules and regulations have substantial affirmative impact to rise agricultural commodity influx to the ECX market. Hence this study focuses on estimating the overall revenue, technical and allocative efficiencies of The Ethiopian Commodity Exchange as well as identifies the inefficiency effects (determinants) for achieving the highest possible transaction performance.

1.2 Statement Of The Problem

In 1990s, however, about five agricultural commodity exchanges were established in African countries, but only the South African Commodity Exchange is remained successful. The rest of the commodity exchanges that launched in Zambia, Zimbabwe, Kenya and Uganda were not successful in attracting large trade volume of the agricultural commodity. Currently their major role has restricted to providing market price information for the users. After 2004, many African countries have established their own commodity exchanges for instance, African Commodity Exchange (ACE) in 2004 by Malawi, Nigerian's Exchange launched in 2006, the Tanzanian's Exchange in 2007 and the Ethiopian Commodity Exchange (ECX) in 2008. The failure for these most of African agricultural commodity exchanges have their own country specific external reason. However, all of them were not structurally attractive for small-scale producers and operational inefficient to remove their marketing problem (Rashid et al. 2010).

Institutionalizing the commodity exchange have numerous substantial benefit, for example (i) it reduces the transaction cost (ii) it is a means to increase market liquidity (iii) it transfers the price risk from smallholder farmers (iv) it creates sustainable supply, trust, order and integrity in the marketing process (Gabre-Madhin and Goggin 2005). These market advantages have a considerable role in stabilizing the commodity market and achieving the economic development goal. But failure to healthy transaction process along the channel of ECX marketing functions such as delivering, weighting, storing, grading, labeling and exchanging on the trading floor, may reduce the efficiency of the ECX market. The inefficiency of given service provider institutions like ECX can be observed mainly from various managerial laziness, unsupportive government policies and impeding lows and regulations of the institute. If there is significant inefficiency effects (determinants) are existed from these sources, it discourages the market actors such as the producers, processors, traders, exporters and consumers as well. The volume and quality of agricultural commodity flowing to the regular market chain is depending upon the level of efficiency of the right institutions operating on a given level of inputs. According to the empirical studies on smallholder farmers in Machakos district of Kenya pointed out by Kamara (2004), effective and efficient transaction process and agricultural commodity market access has a backward effect in improving the on-farm productivity level due to encouraging and competitive commodity price gain for the producers of agricultural commodities.

The profile of the ECX indicates that the resource allocated for labor and capital to facilitate the marketing process has increased since its commencement in 2008 and the aggregate physical quantity of agricultural commodities that have been traded through ECX trading channel more or less have an increasing trend. However, there is no any document that shows the level of overall revenue, technical and allocative efficiency of this service providing institute. Hence this study estimates the Overall Revenue, Technical and Allocative efficiencies of the ECX for the last five years from 2009 to 2013. In addition to estimating the various types of efficiency scores, the study also identifies the potential inefficiency effects or determinants that prohibits the better achievement of the ECX in the transaction process, because the easiest way of improving the volume of the agricultural commodity delivered to this exchange market channel is through shirking the inefficiency sources coming from managerial indolence and inconvenient rules and regulations in the transaction process

1.3 Objective Of The Ttudy

- To estimate the overall revenue, technical and allocative efficiencies of the Ethiopian Commodity Exchange (ECX).
- To identify the major inefficiency effects (determinants) of the Ethiopian Commodity Exchange (ECX) in the transaction process of commodity exchange;
- Comparing the technical efficiency and the significance of inefficiency effects obtained by most applicable SFA and DEA firms' efficiency analysis models.

1.4 Research Questions

This study used to estimates the level of overall revenue, technical and allocative efficiency scores of the Ethiopian Commodity Exchange Authority and also identifies the potential sources of inefficiency effects (determinants) in the agricultural commodity transaction process? In addition, this paper compares the output of most applicable performance analysis models- SFA and DEA- in terms of Overall Revenue and Technical Efficiencies scores.

The specific questions are:

1) Does the Ethiopian Commodity Exchange has no room for improving the Overall Revenue, Technical and Allocative efficiencies?
2) What are major inefficiency effects in the transaction process of the Ethiopian Commodity Exchange (ECX).
3) Does the most applicable performance analysis methodologies: SFA and DEA models arrived on similar overall revenue and technical efficiency scores?

1.5 Significance Of The Study

This study expected to quantify the mean overall revenue, technical and allocative efficiencies of the commodity exchange institutes, which used to indicate the inefficiency space to increase the volume of agricultural commodity entering to the transaction channel, given the existing level of input used. This means the inefficiency fraction of the individual decision-making unit (DMU) is the room to improve the operation of the commodity transaction. Secondly, since this study reveals the technical efficacy level of all seventeen decisions making units (DMUs) located across the country, it helps to investigate the individual DMU's efficiency differences that used to make affirmative measures to improve badly performed decision making unit (DMU). As the Overall Revenue Efficiency, the Technical Efficiency and Allocative efficiency of ECX have never been done before, the contribution of this study is significant in revealing the forgone revenue that could have been earned by exporting the agricultural commodities to the foreign market for the last five consecutive years. In addition, the study identifies the major significant inefficiency effects (determinants) for improving the overall revenue of the country from exporting major agricultural commodity exchanged in the ECX trading floor.

1.6 Scope And Limitation Of The Study

The efficiency score of both the Stochastic Frontier Analysis (SFA) and the Data Envelopment Analysis (DEA) models provide us the relative efficiency of inclusion DMUs located all over the country and adding an extra DMUs affects the level of efficiency score, because both of these models estimate the efficiency score by assuming at least one of the DMU is fully efficient and the rest DMU's efficiency scores estimated relative to the one which is fully efficient firm. Moreover, these efficiency scores of the Ethiopian Commodity Exchange (ECX) couldn't be compared with the efficiency score of other country's Commodity Exchange enterprise.

Unlike the DEA model, the SFA requires a large sample size to have an unbiased estimation of coefficients and technical inefficiency scores. This is because, it applies the econometric model and uses many distributional assumptions of the inefficiency term, as the number of sample size increases, the distributional assumption of inefficiency term approaching to the half normal distribution and SFA performs best in estimating the efficiency scores of the firms (Resti 2000). However, there are only five years (from 2009 to 2013) complete panel data is available for the efficiency analysis for seventeen DMUs and we cannot expand the sample size more than eighty-five. For the fact that there is no statistical test to choose between the SFA and the DEA methodologies, this study uses both methodology just to compare the SFA model's efficiency scores with the efficiency score of DEA model, which is the most suitable approach for the ECX's data set.

1.7 Organization Of The Paper

The paper comprises six chapters; the first chapter describes the background of the study, including a statement of the problem, objective, significance and limitations of the study. The second chapter briefly disused the theoretical framework of efficiency analysis and introduce various alternative approaches for efficiency measurements. The third chapter describes the historical background and the importance of Ethiopian Commodity Exchange Authority. The fourth chapter is all about methodology discussions, comparison on merit and demerit of potential models and specifying the selected models that best fits the data sets of the Ethiopian Commodity Exchange (ECX). The fifth chapter focuses on descriptive data presentation, efficiency analysis result discussion and interpretation of model outputs. The last chapter concludes the analysis result and indicates the potential areas for future studies on the Ethiopian Commodity Exchange market.

Chapter Two: Literature Review

2.1 Definitions and Types Of Efficiency

The theoretical framework of different type efficiency definitions and type of firms' performance analysis was first introduced by Farrell (1957). Farrell had extended the former original works of Debreu (1951) and Koopmans (1951), who was laid the foundation by introducing the concept of efficiency and the way firms' performance could be measured at the firm level in considering the input output relationship. Farrell (1957) introduces two components of firm efficiency: The *Technical Efficiency* and the *Allocative Efficiency*. According to Farrel, the *Technical Efficiency* can be defined as the performance of the given firm to obtain maximum output from a given combination of input used. The given firm is technically efficient when the combination of inputs/ resources give rise to the maximum possible outcome and has no room for improving the output of the firm. Moreover, it can be expressed as the physical relation between inputs/resources (basically labor and capital) and the final outcome/output. In a condition where the firm is produced the same amount output or larger than the previous production level while lessening the use of at least one of the input in the production process, roughly indicates the existence of inefficiency in the production process.

The other type of efficiency is an *Allocative Efficiency*, which is referring to the capacity of the firm to use a set of inputs in optimal proportion with the given price and level of technology or it could be alternatively interpreted as assessing the alternative minimum cost input/resources to achieve a given level of outcome/output for a given intervention, but it also considers how the intervention is distributed or stretched to benefit the community at large. *Allocative efficiency*[4] is widely seen as the benefit of the society in welfare economics (Palmer and Torgerson 1999). The combination of these two kinds of firm efficiency measures would provide the whole *Economic Efficiency* of the firm (Battese et al. 1989)

The third kind of efficiency is the *Scale Efficiency* that refers to the size of the firm. Either the *Technical Efficiency* or *Allocative Efficiency* of the firm doesn't indicate the optimal size of the business; rather the former is concerned about the physical relation between input and output as well as the latter is about assessing the optimal proportion of input/resource mix to achieve a certain level of output/outcome, but these don't indicate that the firm is producing at its optimal size/scale. In investigating the scale efficiency score, the given firm might be too small or too large in size. If the scale efficiency scores revealed that the firm is too small, the firm should require an *Increasing Returns to Scale (IRS)* production function response. Conversely, if the scale efficiency score indicates that the firm is too large, it requires a *Decreasing Returns to Scale (DRS)* production function response (Coelli et al. 2005).

2.2 Concepts Of Technical Efficiency

Technical Efficiency can be referred to the capacity of a given firm to produce the highest possible output or achievement from a given combination of inputs. Firms' failure to operate on their own frontier curve or functioning under the frontier curve indicates the existence of inefficiency resulted from the inappropriate timing or/and unfit methods of applications in the production processes (Llewelyn and Williams 1996). This could be expected to happen due to numerous firms' specific

[4] Coelli et.al 1995, Noted that the original work of Farrel (1957) was used the term Price Efficiency for Allocative efficiency and Overall Efficiency for Economic Efficiency.

technical inefficiency factors such as lack of technical knowledge, managerial skill, responsibility, personal motivation, inconvenient working environment and so on (Scarborough and Kydd 1992).

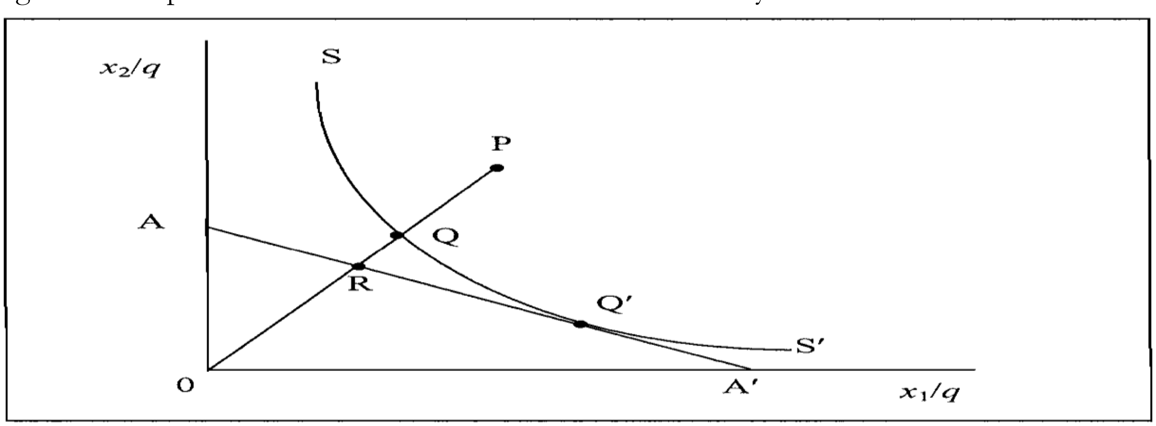
An Allocative Efficiency (price efficiency) is the ability of the decision making units (DMU) or firms to minimize cost or maximize profit/revenue by achieving the equalization of marginal revenue and marginal cost. Allocative Inefficiency refers to the impediment of the better achievement by maximizing the cost of operations or by minimizing the profit in the case of input-oriented efficiency analysis. The sum of these both kinds of efficiencies is collectively known as *the Economic Efficiency* or *Overall Efficiency* (Farrell 1957). In addition to the aforementioned kinds of categories, efficiency can be considered based on the concept of either *input-orientated* or *output-oriented* efficiency calculation. This choice can be determined based on the context that the investigator wants to achieve and availability of data.

2.3 Input-oriented Efficiency And Allocative Efficiency

Originally input-oriented efficiency concept also introduced by Farrell (1957). He illustrated the firm using two factors of production X_1 and X_2, to produce a single output Q by considering CRS frontier function. In order to show the input-oriented efficiency and allocative efficiency concepts, he had used a convex *Iso-quant* curve as shown in the figure 2.1. The fundamental aim to analyze input-oriented efficiency is to address the question that by how much the quantity of factors of production need to be proportionally reduced to achieve the same level of output as before. Fully technically efficient firm could be represented by the set of production points along the curve SS' in the figure 2.1. In a condition where the firm uses a factor of production represented by point P to produce a single output level, the technical inefficiency level of the firm could be represented by the distance QP, which is exactly equal to the proportion by which the factor of production could be reduced to attain technically efficient production level. Hence the technical efficiency of firms in the case of input-oriented efficiency commonly measured by the ratio:

$TE = {}^{OQ}/_{OP}$, which is equals to $1-\left({}^{QP}/_{OP}\right)$, where ${}^{QP}/_{OP}$ is the technical inefficiency portion of the firm. For technically efficient firm, the ratio of QP/OP is zero and the ratio of OQ/OP is equals to one. The value of firm efficiency is always found between 1 and 0, if the TE score is one, it indicates that the firm is technically efficient, which is represented by point Q in the Figure 2.1 as it lies on the isoquant curve.

Figure 2. 1 Input-oriented Technical and Allocative Efficiency



Adopted From (Coelli et al. 2005),

In the case of input oriented efficiency, the *Iso-quant* curve is the lower boundary for both AE and TE. The technically efficient firm produces any point on the *Iso-quant* curve (SS') with various proportions of input. Moreover, the Allocative efficiency measures the optimal proportion of a set of inputs to give the possible maximum output. Having this concept in mind, technically efficient firms which are on the *Iso-quant* curve may not necessarily allocativly efficient. Because investigating the allocative efficiency point requires price data of input and output beside the quantity of output in order to make the *Iso-cost* line AA'. The firm said to be both technically and allocativly efficient at the point where the Isocost line AA' is tangent to the *Iso-quant* curve(SS') , which is point Q'. Point Q' is the point of the least cost combination of inputs from which the firm could derive the maximum output more than any point in the output space. According to Coelli et.al (2005), the ratio RQ/OQ represents the proportional reduction of cost in Input-Oriented efficiency analysis. As the firm removes the allocative inefficiencies and shrinks the ratio to zero, the level of input combination of the firm move from point Q to point Q' that is the point where the firm became allocativly efficient. The illustration of TE and AE of firm P can be expressed as:

$$Technical\ Efficiency\ (TE) = \left({}^{OQ}/_{OP}\right) \text{ and } Allocative\ Efficiency\ (AE) = \left({}^{OR}/_{OQ}\right) \quad (2.1)$$

As we have already discussed above, the Economic Efficiency (some time known as the Overall Efficiency) of a given firm is the product of TE and AE. This can be mathematically represented as:

$$\text{Overall Cost Efficiency (CE)} = TE\ x\ AE \quad (2.2)$$

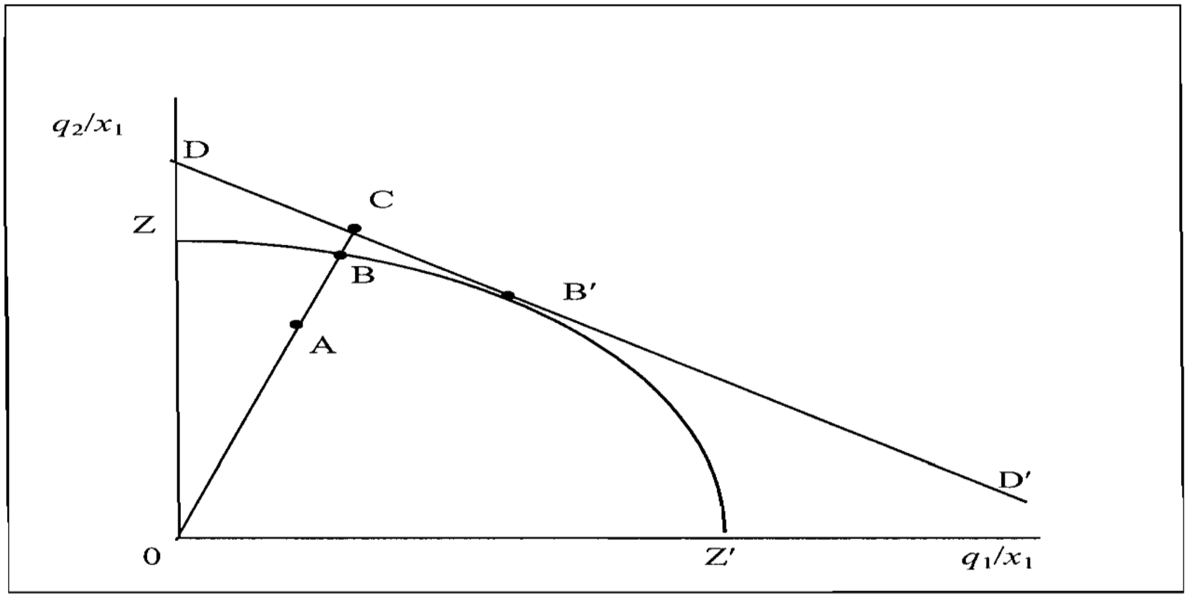
$$= \left({}^{OR}/_{OQ}\right)\ x\ \left({}^{OQ}/_{OP}\right) \quad (2.3)$$

$$= \left({}^{OR}/_{OP}\right) \quad (2.4)$$

2.4 Output- oriented Efficiency

Based on Coelli et al. (2005) and Färe et al (1994), Input-oriented measure of efficiency has focused on how one could proportionally reduce the quantity of inputs mix without affecting the previous level of output. But one may need to address an inverse question that by how much the output could be proportionally improved without altering the quantity of inputs that previously used?. In the case of Output-oriented efficiency measure, the latter issue appropriately addressed, which is an exact inverse application of Input-oriented efficiency analysis. The derivation of the Output-Oriented efficiency used two outputs $(Q_1 and\ Q_2)$ produced from a single input by assuming CRS (constant returns to scale). If the price data of the output are available, the Iso-quant line DD' on the Input-oriented case, become the Iso-revenue line in the Output-oriented approach. In the Figure 2.2, point A represents the inefficient firm, which operates below the set of points on the frontier (curve ZZ').

Figure 2. 2 Output-oriented Allocative and Technical Efficiency.



Adopted from (Coelli et al. 2005),

The segment AB represents the amount by which the output could be increased without adding an extra input. Hence, in the case of Output-Oriented efficiency measure, the technical efficiency is the ratio of OA/OB. If the price data is available, DD' line is an *Iso-revenue* line and the firm at point B' identified as *Allocatively Efficient (AE)* firm. The individual firm operated at point B seen as *Technically Efficient* firm. The distance function for Output-Oriented approach derives the AE and TE as follows:

$$Allocative\ Efficiency\ (AE) = {}^{OB}/_{OC} \quad , \quad and \tag{2.5}$$

$$Technical\ Efficiency\ (TE) = {}^{OA}/_{OB} \tag{2.6}$$

For the firm aimed at maximizing revenue, the Output-oriented approach is more appropriate to quantify the efficiency level and the derivation of the overall revenue efficiency function apply similar distance function procedure with the firm that has cost minimizing objective in Input-Oriented approach. Therefore, the Overall Revenue Efficiency of the firm can be written as:

$$Overall\ Revenue\ Efficiency\ (RE) = {}^{OA}/_{OC} = \left({}^{OA}/_{OC}\right)\left({}^{OA}/_{OB}\right) = AE\ x\ TE \tag{2.7}$$

All the three efficiencies such as RE, TE and AE measures can't be out of the range one and zero.

2.5 Scale Efficiency Concepts And Its Measurements

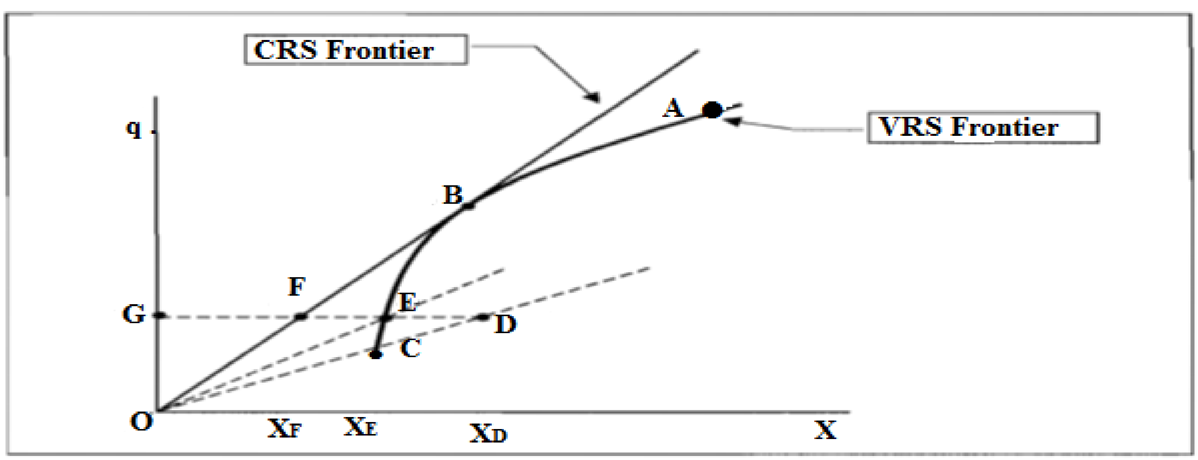
2.5.1 Scale Efficiency Concepts

There were several attempts have been made by earlier literature to measure the Scale Efficiency by disentangling from the productivity change over time such as Banker and Thrall (1992), and Førsund and Hjalmarsson (1979). Among these former literatures on Scale Efficiency, the work of Fare et al. (1998) were prominent in providing fundamental concepts, definitions and elaborations on productivity change and scale efficiency over a given time periods. The more recent work of Balk (2001) has contributed more influential analytical frame work to define the scale efficiency in more plausible way. Balk had also tried to compare and evaluate the earlier works on scale efficiency analysis done by literature such as Wheelock and Wilson (1999), Zofio and Lovell (1999) and Färe et al.(1994);

by decomposing the total productivity change in to three main components: efficiency change, technical change and scale change.

For the firm under Variable Returns to Scale (VRS), the technical efficiency function f(x) bounds the production sets of points between the VRS frontier curve and the horizontal x-axis. The case of one-input and one-output in a given production frontier, which is shown below in fig. 2.3, has been used to depict the derivation and interpretation of technical and scale efficiency analysis. If the firm could produce the output level anywhere on the production frontier it can be considered as technically efficient firm. For instance A, B, C and E are technically efficient firm and the ratio of output and input quantities $(i.e\ Y/X)$ for these four firms equal to each other. However, this doesn't mean that all are equally productive and profitable due to their scale differences. Since firm C is too small it requires an increasing returns to scale production function response that leads towards firm B. Firm A depicted in the Figure 2.3 is too large and it requires a response to decrease the scale of production that leads its production level towards firm C. Firm C should adopt increasing returns to scale (IRS) production function and also Firm A should implement a decreasing returns to scale (DRS) to achieve better outcomes. Both firms are converging towards Firm B in order to attain optimal scale or efficient scale. Any point in the production frontier is not the optimal scale of operation. Hence it could be possible to say Firm B scale operation is *the most operative scale size (MOSS)* or alternatively named as *technically optimal productive scale (TOPS)*. Diagrammatically this point is a tangential point of the line of Variable Returns to Scale (VRS) frontier and the ray from the origin, which represents *Constant Returns to Scale (CRS)*. Any Firm operating below the Variable Returns to Scale frontier is considered as inefficient. This point is depicted as Firm D in the Figure 2.3 (Coelli et al. 2005).

Figure 2. 3 Scale Efficiency



Adopted from (Coelli et al. 2005 : p 61)

2.5.2 The Measure Of Scale Efficiency

A *Scale Efficiency* analysis is used to measure by how much the productivity of very large or very small firms could boost their productivity as they move towards the point of *technically optimal production scale (TOPS)*, which is the point where the scale size of firm B is found in the above diagram. To derive the formula for scale efficiency measure, let us consider point D, which is technically inefficient firm; the productivity of firm of firm D is represented by the ray extended from the origin to firm D. In order to improve the productivity of firm D, the ray extended from the origin to firm point D should move to point E that is found on the Variable Returns to Scale (VRS) frontier, which can be possible by removing the *technical inefficiency,* and then the second measure should be moving along VRS frontier from point E towards point B. Because, the productivity of firm D could be further improve by attaining the *technical optimal production scale (TOPS)* at point B.

In order to drive the scale efficiency for firm D, let us see the technical efficiency of firm D. The TE-VRS of firm D is the distance from the point of firm D to the VRS frontier, which equals to the ratio of GE/GD. This can be written as:

$$Technical\ Efficiency\ (TE_{VRS}) = {}^{GE}/_{GD}\ and \tag{2.13}$$

Similarly, the TE-CRS of firm D also computed as:

$$Technical\ Efficiency\ (TE_{CRS}) = {}^{GF}/_{GD} \tag{2.14}$$

The *Scale Efficiency* is not measured directly; rather it can be measured by computing the ratio of the *Technical Efficiency (TE)* under *Constant Returns to Scale* (CRS) frontier and *Technical Efficiency* under *Variable Returns to Scale (VRS)* efficiencies for each individual DMUs. Therefore the scale efficiency is the ratio of these two kinds of efficiencies for individual firms; these relations can be expressed as:

$$Scale\ Efficiency\ (SE) = \left(\frac{{}^{GF}/_{GD}}{{}^{GE}/_{GD}}\right) = {}^{GF}/_{GE} = {}^{TE_{CRS}}/_{TE_{VRS}} \tag{2.15}$$

Data Envelopment analyses (DEA) approach is most appropriate methodology to calculate the scale efficiency. Because the STATA analysis software calculates these three types of efficiency separately for all DMUs. Following Fare et al. (1998), the general expression for finding out the scale efficiency for the firm that uses a vector of inputs to give rise to a given achievement/output can be written as:

$$SE(x,q) = \left(\frac{\partial_i(x,q/VRS)}{\partial_i(x,q/CRS)}\right) = \left(\frac{TE_{CRS}}{TE_{VRS}}\right) \tag{2.16}$$

2.5 Alternative Approaches For Various Efficiency Measures

2.5.1 Deterministic Approach

The deterministic approach of measuring performance of the firm could be done by applying either parametric (Econometrics) or non-parametric (mathematical programing) method. The fundamental assumptions that used to derive all types the deterministic approach is that the whole deviation of firms from the production frontier is considered as firm specific inefficiency, which means this approach do not have a room to accommodate the random error. The most applicable non-parametric deterministic methodology is known as *Data Envelopment Analysis (DEA)* (Coelli et al. 2005)

Data Envelopment Analysis (DEA) is most applicable a deterministic non-parametric performance measure of the firms. The piece-wise output to input ratio for calculating the performance of each firm was introduce by Farrell (1957), but assessing the efficiency of firms using this method was not gained attention by the literatures at the time. Afriat (1972) also propose the linear program algebraic equation to address the issue. This method was not widely used in the literature for performance analysis of firms. Latter, the more popular work of Charnes et al. (1978) has been reviewed, who has first introduced the term *Data Envelopment Analysis (DEA)* methodology for efficiency analysis both for profit and non-profit oriented firms. The derivation of Data *Envelopment Analysis (DEA)* was proposed by considering Input-oriented measure of efficiency operated under Constant Returns to Scale (CRS). Alternatively, the Variable Returns to Scale (VRS) method was introduced in early 80's for Output-oriented performance analysis (Färe et al. 1983, Banker et al. 1984)

The other alternative method under Deterministic Approach proposed by Aigner and Chu (1968) was *Deterministic Parametric method*. They considered the Cobb-Douglas production function to make use of its functional form as an advantage in order to estimate the production frontier instead of using mathematical form. Following this pioneer work, identified homogenous Cobb-Douglas production frontier was suggested for the firm's performance analysis by Afriat (1972), who assumes the gamma distribution for the inefficiency term u_i and applies the maximum likelihood estimation method. Latter the Modified Least Square Method (MLSM) has been used by Richmond (1974) for efficiency measure. In this model, the inefficiency of the firm is identified totally as error term in the usual regression model, which is given by:

$$y_i = f(x_i\ ,\beta)\exp(-u_i\ ) \quad (2.8)$$

Where y_i, is output achieved, x_i is a vector of inputs used to achieve the objective or output, β is unknown parameter to be estimated and u_i is considered as the inefficiency of the firm which is non-negative random variable. The assumption that u_i is being positive is quite appropriate for the model as efficiency cannot be negative.

The technical efficiency in deterministic frontier function is defined as the ratio of actual observable output/achievement to the potential output/achievement. It expressed functionally as:

$$TE_i = \frac{(X_i,\beta)\exp(u_i)}{f(x_i,\beta)} = \exp(-u_i) \quad (2.9)$$

The above relation indicates that as the efficiency of a firm is between 0 and 1, then $u_i \neq 0$, and the maximum technical efficiency level is at $TE_i = 1$ as $u_i = 0$. The main critics of such *Deterministic Frontier Model* is that the model assumes the entire error term of the model as inefficacy term of the firm, which is a bit far from the reality that the error term of the model is not entirely coming from the inefficiency. However, all types of *Deterministic Frontier Approaches* such as DEA, Cobb-Douglas production frontier and Modified Least Square Methods (MLSM) are not considering the statistical noise coming from measurement error and omitted variable so that the whole variation from the frontier is assumed as inefficiency coming only from inefficiency effects. Hence, The shortfall of the *Deterministic Frontier* model is that the model unable to separate the composite error term in to statistical noise and inefficiency term, which can be possible to segregate the random error term and the inefficiency term in *Stochastic Frontier Production Function* model. This is the major rationale that magnifies the need of the *Stochastic Frontier Production Function,* and makes the method most popular in recent efficiency analysis literatures.

2.5.2 Stochastic Frontier Production Function Approach

The Stochastic Frontier Production Function (SFPF), shortly known by *Stochastic Frontier Analysis (SFA)* model, which is the most popular methodology for profit and non-profit oriented firm's performance measure, which has independently proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977). This model uses statistical methods to estimate the parametric representation of inputs (Kalirajan 1994). The *Stochastic Frontier Analysis (SFA)* model is exactly similar to the *Deterministic Parametric* method discussed above except that the composed random error term in *the Deterministic parametric equation* ε decomposed in two: the statistical noise (v_i) and the inefficiency term (u_i) in *Stochastic Frontier Analysis (SFA).* The statistical noise (v_i) newly introduced in the *SFA* for considering the random effect coming from measurement error, luck and omitted variable, which are beyond the firm's control in the production process. The *SFA* is mainly used for the estimation of efficiency of the firm. The general functional form for measuring technical efficiency using the SFA model in the case of cross-sectional data is given as:

$$y_i = f(x_i\,, \beta)\exp(v_i - u_i\,) \qquad (2.10)$$

In this model, the composite error term ε_i has a decomposed into v_i, which represents the statistical noise beyond the firm's control and u_i that indicate the inefficiency of the firm. The latter can be improved by the effort of the firm via reducing the contribution of inefficiency factors in the production process. The statistical noise v_i is independently and identically distributed $N(0, \delta^2_{vi})$, but the inefficiency u_i has non-negative and one-sided distribution $N^+(0, \sigma^2_{ui})$; the derivation of the decomposition of the error term is extensively explained in Battese and Coelli (1995). The technical efficiency in the Stochastic Frontier Production Function given as:

$$TE_i = \frac{(X_i,\beta)\exp(v_{i-}u_i)}{f(x_i,\beta)\exp(v_i)} = \exp(-u_i) \qquad (2.11)$$

This function shows the theoretical assumption of the decomposition between the random error term and the inefficiency term. The very challenging task here is decomposing the random error term and inefficiency, because both of these components are unobservable component of the econometric equation. The methodology that used to decompose the composite error term had first introduced by Jondrow et al. (1982) that had solved the dissonance between the theoretical assumption and the practical application of econometrics by decomposing the random error term and inefficiency term. This can be done by finding the expected value of u_i conditioning to ε_i, $ie. E(u_i/\varepsilon_i)$. According to Battese and Coelli (1995), the above applications of the Frontier Production Function for cross-sectional data had expanded to the panel data by incorporating the time dimension for i^{th} firms or decision making units (DMU's) as follows:

$$y_{it} = f(x_{it}\,, \beta)\exp(v_{it} - u_{it}\,) \qquad (2.12)$$

Where y_{it} is the i^{th} DMUs in t^{th} time period; x_{it} is a vector of inputs belonging to i^{th} DMUs in t^{th} periods and β represents the parameter to be estimated. .

2.7 Panel Data Model For Stochastic Frontier Production Function

As pointed out by Aigner et al. (1977), all the application and conceptual frame work for the efficiency analysis used in cross-sectional data is similar for the application of panel data except incorporating the time dimension in the equation for accommodating panel data in SFA model. The model primarily used to get consistent prediction of TE and helps to compute the TE change over a given time period. The panel data version of for SFA model is expressed as:

$$In\ q_{it} = X'_{it}B_i + (v_{it} - u_{it}) \quad (2.17)$$

Where: t is used to represent the time dimension over a given period for $i's$ firms.

2.8 Identifying Inefficiency Effects

The other more fundamental importance of applying the DEA and SFA models is to identify the significant inefficiency determinants (inefficiency effects) those affect the transaction processes. In reality, there are some variables, which are neither the production inputs nor the outputs, but they could affect the performance of the firm exogenously. These variables could be managerial aspects, internal regulation or polices of the sectors. Such inefficiency determinants (effects) could affect the production process in three basic dimensions: i) they may cause to shift the production frontier upward or downward and thus affects the inefficiency distribution of individual the firms, ii) They may affect the scale of the firms positively or negatively that could possibly affect the inefficiency distribution as well, iii) These variables could also affect both the scale and the production frontier simultaneously that has greatly affect the distribution of inefficiency (Belotti and Ilardi 2012). Identifying the inefficiency effect is about revealing the significant determinants those hinder the production process without being an input or output of the firms.

2.9 Summery

Farrel defined both technical and allocative efficiencies originally that technical efficiency is referring to achieving maximum output by operating on a given combination of inputs. This concept of efficiency referring to the physical relationship between inputs and outputs, but it doesn't indicate the profitability point of a given firm. The other is allocative efficiency, which can be calculated if the price data is available, which indicates the point where the minimum cost combination of inputs is located in a given production frontier of the firm in Input-Oriented efficiency analysis. The allocative efficiency in Output-Oriented efficiency analysis used to show the extent to which the output mix is appropriate to earn the maximum revenue. The third type of efficiency is the scale efficiency that shows the optimum production size of the firm. The analysis of efficiency can be differ based on already available data type and objective of the investigator. It could be used either cost minimizing function by applying Input-Oriented efficiency analysis approach or one can use revenue/profit maximizing function using Output-Oriented approach. The interpretation of the result is different based on the kind of orientation used in analyzing software package. The efficiency score of former approach shows by how much all inputs need to be proportionally reduced to achieve the same level of output as before, while the latter approach reveals that the proportion of output that could be improved without adding an extra input in the production process.

There are two more applicable efficiency model analysis are intensively used by literatures namely, DEA and SFA, which considers all firms in the industry are not fully efficient. These models quantify the efficiency level of each firm relative to the best performed one. In addition, these models could also identify the significant inefficiency effects (determinants) of the given firm, which hinder the production process.

Chapter Three: Market Reform And The Trajectory of Agricultural Commodities Market in Ethiopia

The Implementation of market reform in Ethiopia was highly associated with the overthrowing of the socialist-oriented central government by civil war in 1991. The efforts to modernize the grain market has long history, the Ethiopian Grain Corporation (EGC) was established during the country was led by Monarch rulers in 1960's, aiming to stabilize grain market prices for local consumption, export and import trading. Later, the military junta took over the government authority and introduces the country with socialist oriented market-economy. Based on this political economy framework, the Ethiopian Grain Corporation (EGC) was restructured to be replaced by the Ethiopian Agricultural Marketing Corporation (EAMC) to precede the socialist-oriented political economy ideology in 1976 with the explicit objective of stabilizing basic agricultural commodity price. However, either during the emperor rulers or during the Military Regime *(Derge Regime)*, the price stabilizing objective of the organization was not efficiently achieved. The marketing policy at that time also restricts the inter-regional agricultural commodity trade unless the relocation is officially permitted (Lirenso 1993). Obliging the farmer to stick to the quota system exposed the overall economy to the three basic problems: 1) the policy pushed the grain producers to poverty trap by depressing the farmers' income, 2) reduces the production due to lower price fixed by the government and, 3) the policy uses as a tool to transfer the resources from rural poor to urban inhabitants, which create a suitable opportunity for the urban households to accumulating asset while living in low cost food grain price bought from Ethiopian Agricultural Marketing Corporation (EAMC) (Dercon 1995, Franzel et al. 1989, Lirenso 1993).

After 1991, in association with the overthrow of the Military Junta, the country's market economy policy has made a dramatic change by declaring a free market policy in most of the economic sectors and announced that any market participant, whether the private enterprises, government run-organizations or cooperative unions in the economy had gotten equal access to computing and fix the market price. The policy introduces caseation of quota system by declaring free market principles on some sector of the economy, of which the agricultural sector was one of the focus area on which the government advocates price competition of agricultural commodities (Gabre-Madhin 2001).

3.1 Ethiopian Commodity Exchange As Market Facilitating Institution

The new institutional economics wave highly stresses the importance of market institutions for facilitating the marketing process for the efficient and effective delivery of agricultural commodities to reach its final destination. Actually market requires the government structure that helps to transform the traditional exchange system to modern and trust full marketing structure, thereby confirms safe and predictable political foundation in a given economic environment (Weingast 1993). Without putting appropriate institutions in place, the market economy could not successfully operate in many countries (North and Wallis 1994). The Ethiopian Commodity Exchange Authority has launched officially in April, 2008 being under the supervision of the Ministry of Agriculture and Rural Development (MoARD) in proclamation No. 151/2007 with a vision of "to revolutionize Ethiopian agriculture through creating a dynamic, forward-looking, efficient, and an orderly marketing system that serves all" (Gabre-Madhin 2006).

The exchange process is governed by rules and regulations of contracts legally ratified by legislators to create organized, reliable and efficient market so that all actors could benefit from the process proportionally and fairly. (Gabre-Madhin 2009). The free market modality waved in 80's and 90's by the western countries have been widely advocated that the market to be free and the price of commodities to be competitive to attain "market clearing price". However, in some part of the world such as Africa, Latin America and Asia, where there is weak infrastructure and missing right marketing institutions, it is challenging to achieve market-clearing price in the actual market. Hence, to tackle the "missing right market institute", ECX has been realized towards filling the gap for the need of an integrated end-to-end marketing channel for some selected agricultural commodities aiming at: 1) increasing the quantity and quality of specially exported agricultural commodities to boost foreign currency revenue for the country and, 2) to benefit all marketing actors along the line proportionally by improving integrity, efficiency, trust, order and transparency while reducing the transaction cost along the line. Even though policy framework is the major tool to boost the aggregate transaction volume, but it doesn't provide the buyers and sellers ample market information, full trust and offer guarantee on grade and the levels of their produce. These require the establishment of the right institution besides the policy tool as well (Gemech and Struthers 2007).

3.2 Why Commodity Exchange Is Required?

The commodity exchange institution is modern organization that enables buyers and sellers to escape the intermediaries and trade among themselves directly with governed rules and regulations and ownership transfer would take place, if both parties would accept the competitive price during transaction (Gabre-Madhin 2001). In a broader sense, commodity exchange is any institutional market place equipped with sophisticated electronic-based trading system in which the transaction is carried out trusting the level and grade of the exchange institute and the physical commodities may or may not inspect by buyers to offer the price. Moreover the commodity exchange allows transparent and maximum possible competitions among all parties at the moment. The mechanism creates a single-market mechanism to converge all sellers and buyers together at a point in time and large concentration of commodities with different standard of various agricultural commodities are brought to the place where effective "price discoveries" could take place.

In the Ethiopian context, the agricultural commodity market exchange system as evidenced by lack of trust among market actors, no contract enforcement, asymmetric market information and unstandardized level and grading system. These constraints made the operations of the agricultural commodity exchange channel narrow and fragmented. Before the commencement of ECX, the market actors traded in short distance, contact few partners, conduct few markets and use limited storage mechanism. With the existence of these market constraints, market reform is a very necessary measure, but not a sufficient condition for enhancing market performance holistically. Hence it needs an institutional response to overcome these failures, which is the main motive for the establishment of the Ethiopian Commodity Exchange (ECX) thereby transform the agricultural commodity market to an integrated, sustainable, standardize and trustful channel that benefits all actors in creating a transparent market and prices are determined by auction (Gabre-Madhin and Goggin 2005).

3.3 How The Commodity Exchange Works

The Ethiopian commodity exchange supervised by a Board of Directors composed of eleven members. Five members of the Board have selected from the ECX member and the rest six members of the board of director, including the chairperson shall be appointed by the Ministry of Agriculture and Rural Development (MoARD). The management of the ECX has organized by professional expertise and it is an autonomous decision making unit to respond to the problems and claims during business operation.

Membership of the ECX: - the exchange on the ECX trading floor can be carried out only by members of the exchange. ECX provides basically two types membership seat for the exchange participants: the *Ordinary* and *Limited membership* seats. Each kind of membership has its own right in the exchange operation. An *Ordinary Members* can be a *Trading Member* or *Intermediary Member*. Those who own *Trading Member* license could trade only on his/her account while *Intermediary Member* could trade either on his/her account or on the behalf of other clients. The other category is *Limited Membership* seat and those who have a license for this Limited membership seat can be registered either for *Limited Trading* member or *Limited Intermediary* members. Those traders who own *Limited Trading* membership seat could be engaged in commodity trading either as a seller or a buyer. The other type of membership under *Limited membership* is *a Limited Intermediary member*, which could be engaged in trading only as a seller. The vacated membership seats are sold by announcing an invitation to bid, and currently the value of the membership seat is quite expensive.

Warehouse and Central Depository Operations: - any member, clients or representatives, who want to sell her/his commodities could deposit to the warehouse and the warehouse executes the following services soon after delivery of commodities:

I. Earmarking separate storage area
II. Taking the sample and grade the commodities
III. Weigh and issue printout Electronic Goods Received Note for depositors and
IV. Store the commodities based on the grade specification

The rules of the Ethiopian Commodity Exchange offers a right to the exchange Authority in order to fix the expiry date of each commodity to stay in the warehouse (ECX 2010,). Due to this legal framework, the expiry date in the warehouse has amended time to time. For example, the current warehouse expire date for coffee is twenty days, which has been sixty days at the beginning in 2008. In addition, this rule also declares that the minimum allowable deposited quantity of the agricultural commodities is also determined by the exchange authority as required. Hence the minimum allowable quantity of all agricultural commodities to deliver to the warehouse of ECX is fifty quintals except for coffee, which is currently thirty quintals.

ECX Trading Floor Operations: - Six types of agricultural commodities are traded on the spot trading floor of ECX such as Coffee, Sesame, Pea Bean, Mung Bean, Maize and Wheat. The exchange is undertaking as open and auction type trading to ensure price discovery and being competitive. The sellers use the Warehouse Receipt issued by the Central Depository (DC) and the buyers use a Settlement Account fund deposited in one of the ECX partner Bank[5]. Then the sellers offer their commodity price and the buyers engaged in bidding the price on the trading floor. If both parties agree to be exchanged, shake their hands and made a contract on the Order Ticket in front of the ECX staff and surveillance camera on the spot. Soon after checking the availability of money in the Bank for the buyer and the validity of warehouse receipts for the seller, ECX assured and reconcile the contract of both parties within few minutes. Finally the cash and commodity ownership transferring processes would be proceeded by the "Clearing and Settlement" department of the ECX.

Chapter Four: Methodology Of The Study

4.1 Data And Analytical Framework

4.1.1 Type and Source Of Data

The aim of this study is to estimate the efficiency of ECX from 2009 to 2013 using a panel data set. The monetary values of input and output indicators are quite crucial to assess the efficiency of individual DMUs of ECX. These data have obtained from the profile of the Ethiopian Commodity Exchange institutions. The output data have obtained from the "Central Depositary" section, where all commodities daily delivered to the warehouse for all locations electronically reported. The report includes the grade, amount, type and other marketing information of the commodity from each location in daily base using the networked electronic systems. The expenditure used for facilitating the marketing process has obtained from the balance sheet and income statement of the "Finance and Treasury Section". The other important data that have been used for aggregating different quality, value and quantity of various commodities is the price of each commodity per day per ton from 2009 to 2013. This data have obtained from "Trading Unit" database. The panel data model has employed for the efficiency analysis and the total sample size is 85. The analysis assumes the data obtained from seventeen ECX locations, which considered as individual Decision Making Unites (DMU), for five consecutive years from 2009 to 2013.

In addition, in order to improve the operational efficiency, estimating the Overall Revenue Efficiency level of ECX is not enough but also it needs identifying the major inefficiency effects, which are crucial to reduce the inefficiency effects that influence the exchange process. Therefore the inefficacy effects of Overall Revenue of the ECX are identified by conducting the primary data collected from two hundred members of the exchange.

4.2 Input and Output Variable Identification

All expenditure for running the transaction process used as input, but the consideration of output varies across different sectors of the economy for example for producing firm the output can be used the exact amount of the produce. However, for service provider enterprise the output can be considered as an output - indicator, which is an aggregate of the value of services being provided.

4.2.1 For Non-Profit Service Provider Output Measures

Measuring the output of the firms that are engaged in the production of tangible and quantifiable products and services are easier than measuring output for some kinds of service provider institutes,

[5] Currently ECX has linked electronicaly with 11 Settlement Banks and these banks have dedecated ECX settlement team at their head office. see http://www.ecx.com.et/Operations.aspx

which may not value only in terms of monetary term. For instance, measuring the output of soap, car and mobile phone producing firms are easier than measuring the output for some service provider institutes such as universities, police stations, utility providers, hospitals, age-care facilities, airways, railways, schools, banks, insurance companies and commodity exchange institutions. For these types of serves provider industries, where their output indirectly measured as an output-indicates or the exact unit price of the output is difficult to determine, the *Data Envelopment Analysis (DEA)* is the most preferable method used by numerous literatures to measure the firms' performance. However, *Stochastic Frontier Analysis (SFA)* also observed in some literature even for such service provider enterprises as well. Determining the most relevant output indicator for such service provider institutions is quite crucial to get findings that are more reliable and sound conclusions (Coelli et al. 2005).

The Ethiopian Commodity Exchange (ECX) has established with the aim of facilitating the commodity marketing process by bringing both the sellers and buyers together. The most appropriate output-indicator for this study is the annual aggregated monetary value of the commodities that have been exchanged for the last five solid years. Hence, in this study the aggregated monetary value of all six agricultural commodities that are currently exchanged on the ECX trading floor such as Coffee, Pea Bean, Sesame, Green Mug-bean, Maize and Wheat have used as an output-indicator for measuring an overall (operational) efficiency of each Decision Making Units (DMU).

4.2.2 Determining Input Categories

According compressive work of Coelli et al. (2005), the most commonly used way of categorizing of input for measuring firms' performance are: Capital (K), Labor (L)Servicesy (E), Material Used (M) and Purchased Service (S). This type of categorizing input is commonly known as KLEMS approach. However, such kind of category does not holistically applied for the entire sectors of the enterprises. In most of the cases, literatures use the aggregate value of the last three components as a single input category known as "other inputs". In this study, all inputs categorized into four main components of the major expenditure entry of the ECX: Labor (L), Capital (K), Office and Warehouse Rent (R) and Other Material (OM).

Labor: - is the major expenditure on production and service provider enterprises. For measuring the efficiency, literatures used labor as a compulsory component for running the analysis. The data could be measured in terms of number of employees, hours of work, the value of full-time workers and bill of wage and salary. Depending on the availability and suitability of data, one could use either of these labor data as input component. In the case that the employees are varied in educational skill, amount of salary, number of work hours and other criteria, the best way to measure labor while normalizing the employee variation is by aggregating the value to obtain a single "labor input" component (Coelli et al. 2005). The labor data that are used as input in this study is obtained by aggregating the annual expenditure for "loading-unloading" and the expenditure for "wage and salary", which summarized as "personnel expense" from 2009 to 2013 for each DMU.

Capital: - proper and reliable capital measurement principle is quite crucial for efficiency analysis of a given firm or service provider enterprises. Since capital assets are purchased for long year's usage and expected to give service until it will be replaced or worn-out, the total face value of the asset does not use as capital for the analysis. Instead, the aggregate flow of capital service of all durable assets is used as capital input. This flow of capital service for a given accounting period is commonly known as depreciation expense (Coelli et al. 2005). The capital that is considered in this paper as a component of input is the aggregate capital depreciation of various durable assets, which has picked up from the annual income statement report of the ECX that has recorded as "Depreciation Expense"

Office and Ware House Rent: - Since the establishment of ECX in 2008, the Authority has not built even a single building for its own use. Hence, the "office and warehouse rent" is proportionally quite high cost, which is even more than the capital depreciation expense over the last five years.

Other Inputs: - this category has used in many literatures as an input component for producer or service provider industries for efficiency analysis, which is a linear sum of miscellaneous operational expenditures. Concerning this study "other input" category of input comprises four basic elements: *i)* material expenditure such as non-durable stationary materials, *ii)* Utilities bills (telephone, internet, post etc.), *iii)* Energy (fuel cost) and, *iv)* weighbridge services cost.

4.3 Determinants Of Operational Efficiency

The determinants of efficiency for service providing enterprises are mainly coming from inconvenient policy, internal regulation problems and managerial bureaucracy. In order to identify the major determinants it required to conduct primary data collection through interviews and discussion with key informants. The major inefficiency effects for ECX could be coming from sellers, buyers or institutional lows and regulations. The fundamental challenge to explore the determinants were in which group of the exchange participants of the ECX should concentrate on so as to identify the major constraints. In order to identify the problems there were two tasks has executed before preparing the structured questionnaire. First, conducting the customer service section where to know which groups of the exchange participants repeatedly claimed about some issues in the exchange process. In this regard, the sellers were claiming much for the modification of many fundamental laws and regulation of the ECX and the buyers were not raised policy issues. Secondly, it requires conducting key informants who are engaged in the exchange process for a long time from both the seller and buyers side. This pre-information also indicates that the buyers are benefited more from the exchange process than the former unordered system of the agricultural commodity exchange process while the sellers/suppliers assumed as if they are the losers due to many factors that will be explained later. All the pre-information that has been gathered has indicated that most the operational inefficiency of the ECX coming from inconvenient institutional laws and regulation of the Authority that are assumed as unfair by the sellers/suppliers. Hence, the influential inefficiency effects (determinants) have explored by collecting a total sample size of two-hundred peoples from the seller group. The data has been collected by random sampling technique from those coming to the exchange floor for ten days. Since buyers and sellers wear a different jacket for exchange operation, sellers are easily identified for interviewing them.

4.3.1 Determinant Variable Selection And Hypothesized Sign

The major inefficiency effect variables, which are supposed to reduce the delivery of the output indicators (exchanged agricultural commodities) to input ratio, and the expected sign is hypothesized as follows:

I. *The membership seat stock value (VAIST)*: an ordered dummy variable, which used to capture the skyrocketing of the stock value of membership seat. The analysis uses 1 if the value of the stock is extremely high and 0, otherwise. The hypothesis for this variable is associated with the lows and regulations of acquiring ECX membership seat. The lows of ECX states that there are basically two type membership's seats for the exchange participants: the *Ordinary member* and *Limited membership* seats. For example, under *Ordinary member* category, there are members who have an *Intermediary Membership* seat. These members could trade either on their account or on the behalf of their clients. The clients for each *Intermediary Member* are limited in number and they could be engaged in the exchange process only when the stockowner ratified for them, as they are his/her clients. For the fact that the membership stock value is sold by auction and the number of seats is limited, the value of the membership seat for the sellers/suppliers has tremendously increased from time to time that predominantly hinders the clients/suppliers not to have their own membership seat. Therefore, clients exposed to pay a very high commission per sell for those who have an *Intermediary Membership* seat. This situation prohibits many traders not to sell their commodities in the ECX trading floor that reduces the aggregate value of the output indicator.

II. *Warehouse stay of commodities (WHLC's)*: - is a dummy variable that used to capture the effect shortening warehouse stay of commodities from time to time for suppliers (sellers) by ECX legislators. The dummy variable WHLC's takes 1 if the suppliers disfavor the current expire date of their commodities to stay in the warehouse and 0, otherwise. The rules of ECX states that the warehouses expire date of each commodity shall be determined by the ECX Authority. For instance the warehouse expiry date for coffee in 2008 has been two months; this means the coffee that has delivered to the warehouse could stay for two months while waiting for the best price without incurring a 3.5% additional payment per sale of commodities. However, currently warehouse expire date of this commodity has shortened to 20 days, which compelled the suppliers to sell their commodities within 20 days whatever the price is. If the depositor couldn't get a favorable price to sell for his/her commodity within the limited day gap, the depositor obliged to pay an extra 3.5 % commission for the warehouse rent. In most of the cases the depositors forced to sell even below the market-clearing price before the expiry date has notified. Hence, suppliers forced to store their commodity by their own store to avoid the risk of incurring an extra cost per sell of the commodity. This situation expected to reduce the inflow of commodities to the warehouse of ECX.

III. *Unlimited due date of buyers' money in bank activated for ECX exchange (UBLECX):* the Dummy variable *UBLECX* has used 1 for those in favor of the implementation of the expiry date of the Settlement Account of buyers' money in partner banks and 0, otherwise. The law of the ECX declare that all the exporters (buyers) need to have their own separate settlement account that's used for ECX exchange process in the eleven partner Banks and all buyers should have enough money in their debt settlement account before entering to the commodity exchange trading floor. The money in a bank that is active for ECX commodity exchange has no limited expiry date as equivalent to the stay of commodity in ECX warehouse for suppliers. The suppliers condemn this situation because the law does not treat both parties equally and the suppliers assumed that this law is in favor of buyers (exporters). Suppliers are always complaining for such unequal treatment of ECX laws and regulation that expected to reduce the size of the commodity delivered to the ECX warehouse for exchange.

IV. *Asymmetric information (ASSYIN):* the dummy variable ASSYIN uses 1 if asymmetric market information deteriorates commodity price at ECX trading floor and 0, otherwise. The sellers also complained that the buyers have high possibility of getting informal information from ECX warehouses about the suppliers' commodities that are approaching to expire date. This information helps buyers to raise their bargaining power to make the price below the market-clearing price for that specific seller. In this case, the informal information obtained from the warehouse would harm the seller/supplier and benefits the buyers (exporters) in the trading floor. Such unidirectional marketing information discourages the suppliers to work with the ECX and negatively affect the size of output exchanged in the trading floor.

V. *Devaluating the commodity level during grading at the warehouse (AVGCs):* the dummy variable *AVGSs* takes 1 if the seller presumed that his/her commodity level has devaluated at the time of grading the commodity at warehouse and 0, otherwise. Suppliers assumed that the agents of rich exporters in various ECX warehouse locations lobby the quality control experts to devaluate their agricultural commodities delivered to the warehouse, which help the buyers (exporters) to buy at a lower price at ECX trading floor and get abnormal profit at sell.

VI. *The lower limit requirement for supplier (LLRCs):* a dummy variable *LLRCs* takes 1 if supplier would think that the lower limit requirement affects the size of the commodity inflow to the ECX warehouse and, 0 otherwise. In addition to members of ECX legally accredited farmers, cooperative unions and State farms could supply the agricultural commodities to the nearby ECX warehouses all over the county. Nevertheless, the law and regulation of the ECX declared that the minimum quantity delivered to the warehouse is one lot (30 quintals). Even large quantity of export standard quality of agricultural commodities is marketed locally due to minimum requirement criteria of ECX's rules and regulation. This decrease not only the amount that is exchanged at ECX trading floor, but also significantly reduces the foreign currency obtained from exported commodities such as Coffee and Sesame.

4.4 Analytical Model Selection And Specification

4.4.1 Comparison Between SFA and DEA Approaches;

Technical efficiency can be measured as a proportion of realized productivity of output to the possible productivity may or may not realize. The trustworthiness of the measure of technical efficiency relays on how precisely the actual output and inputs have measured and how reasonably the appropriate model has chosen for the estimation. The most recent popular approach to estimate the possible output or achievement of a given firm is the *Data Envelopment Analysis (DEA)* and the *Stochastic Frontier Production Function Analysis,* which is shortly named as *Stochastic Frontier Analysis (SFA)*. Traditionally, these methodologies have categorized as non-parametric and parametric approaches respectively. According to Coelli et al. (2005) comparison, these two mostly applied models are not free from critics and both of them have their own weakness and strength. He notified that using DEA method has a merit over SFA in that:

i. DEA doesn't require a distributional assumption for its inefficiency term
ii. DEA don't require functional form selection as SFA

These two basic points are the merits of the DEA methods users. Conversely, one should pay attention these critics for running the SFA method and being careless about these points may lead to biased efficiency score. On the other hand, the two fundamental weaknesses in DEA method are:

i. DEA doesn't assume the statistical noise coming from measurement error or omitted variable
ii. As DEA is calculated through mathematical programming, it is not appropriate to use standard hypothesis testing

The review of comparisons made by Mortimer (2002) revealed that still there is no holistic approach that solves the major weakness of these prominent efficiency analysis methodologies. But he suggests that DEA efficiency estimation is more accurate if:

i. The statistical nose of the data set is lesser and
ii. The sample size of the data set is smaller
iii. The output is measured indirectly as an output indicator for service provider industries

Though, the "small" and "big" sample size is not specified in Mortimer (2002), the simulation work of Resti (2000) , compared "big" and "small" size data and she considered that 500 is a big sample size and 50 is the small sample size. Based on these comparisons, SFA perform best for big sample size and DEA model preferably a best fit for small size data in terms of accuracy of efficiency score estimation.

To sum up, there is no best method generally solves the whole problem of both DEA and SFA methods. Actually, knowing the above weakness and strengths may help to choose one from the other but it is not complete. For instance Mortimer (Mortimer 2002) has recommended to choose DEA model if the sample size is small and measurement error is lesser. However, one may know the sample size simply by rough observation of the given data set yet it is difficult to know the measurement error is either small or large by looking at the data set without doing the SFA model. Hence, it is logical to use both methods and compare the results (Von Der Goltz 2010). Therefore, this study uses both DEA and SFA methods, because there is no a statistical means to choose one method over the other.

4.4.2 Stochastic Frontier Production Function Model Specification

Within short time difference in 1977 two famous articles have been published independently by Aigner et al. (1977) and Meeusen and Van den Broeck (1977). The main idea of these articles has introduced the composite error term, which was a new version of SFA model at the time. Since then numerous improvements have been made to boost the accuracy of estimation by many scholars, but the work of Kumbhakar and Lovell (1998) were prominent in providing a better justification on how the SFA and its composite error were developed. However, the model is still not free from critics. The first critique is that the model cannot accommodate the heterogeneity of the firms and quality differences of output that may lead to efficiency score bias. Secondly, as the model has no priory justification for the error term distributions, misuse of these distributions may become a source of bias on the outcome of the model. In contrary, the major advantage of this model is that one could make statistical test between the two types of the functional form of stochastic frontier models: the *Cobb-Douglas* and *Translog* functions. These two functional forms have their own quality of estimation and suitability of a given date based on the number of parameters to be estimated and the type of data used for analysis. In most of the cases, *Cobb-Douglas production function* is more appropriate to estimate fewer parameters, it is easy to compute and interpret coefficients relative to *Translog function* and it is not preferable to estimate multiple outputs as dependent variables (Sarafidis 2002, Coelli et al. 2005).

The *Cobb-Douglas production frontier function* is specified as:

$$In(OUTP)_{it} = \beta_0 + \beta_{it}(InLab) + \beta_{it}(InCap) + \beta_{it}(InRent) + \beta_{it}(InO\_M) + v_{it-}u_{it} \ldots \text{(4.1)}$$

Where:

OUTP = the value of output-indicator that represents the monetary value all commodities exchanged by i^{th} DMU for t period.

Lab = the expenditure for labor for i^{th} DMU for t periods

Cap = the Capital depreciation for i^{th} DMU for t periods

Rent = the expenditure for Office and warehouse rent for i^{th} DMU for t periods

OM = the expenditure for other materials (Materials, Stationary, Utility bill, Energy, Weighbridge service cost)

v_{it} = Identically and independently distributed statistical noise, $i.i.N(0, \delta_v^2)$ statistical noise, which supposed to capture random effect beyond the control of i^{th} DMU over "t" period.

u_{it} =Non-negative technical inefficiency term that identically and independently distributed $i.i.N^{+}(\mu + \delta_{ui}^{2})$, which expect to capture the inefficiency effect on it DMU over "t" time period.

The *Translog function* could solve the limitation of *Cobb-Douglas function* by accommodating more parameters in the model and it is more flexible to analyze multiple outputs as a dependent variable. In order to choose the most suitable functional form, one should conduct the Likelihood Ratio Test and apply the standard rejection rule. Testing procedure could be made among the restricted model, which is represented by *a Cobb-Douglas function* where the cross products and the squares of inputs are equal to zero, and unrestricted model which represented by *translog function* that creates the squares and cross products of inputs to run the model (Battese et al. 1989). The *translog* stochastic production function is specified as:

$$In(y)_{it} = \beta_0 + \sum_{j=1}^{17} \beta_j InX_{jit} + {}^{1}/_{2} \sum_{j=1}^{17} \sum_{k=1}^{17} \beta_{jk} InX_{jit} InX_{kit} + (v_{it} - u_{it}) \qquad (4.2)$$

The subscript j and t represents the number of DMU's and years respectively.

Where:

$y =$ the value of output indicator that has been exchanged delivering from i[th] DMU for "t" years

$X_1 =$ Labour expenditure for i[th] DMU over "t" years

X_2 = Capital service flow (Capital depreciation) of i[th] DMU over "t" years

X_3 = Expenditure for Office and warehouse rent for i[th] DMU over "t" years

X_4 = Others expenditure (including stationary material, energy, utility expense, weight bridge service) for i[th] DMU over "t" years

v_{it} = Identically and independently distributed statistical noise, $i.i.N(0, \delta_v^2)$ statistical noise, which supposed to capture random effect beyond the control of i[th] DMU over "t" time period.

u_{it} = Non-negative technical inefficiency effect that identically and independently Distributed, $i.i.N^{+}(\mu + \delta_{ui}^{2})$, which expect to capture inefficiency effect of i[th] DMU over "t" period.

4.4.3 Data Envelopment Analysis (DEA) Specification

In the case DEA approach, the model considers at least one DMU is fully efficient (100 %) and the efficiency score of the rest will be estimated relative to the referenced one. The main pitfall for this technique is that any deviation from the frontier as a whole is considered as inefficacy of the Decision-Making Unit (DMU). Since the measurement error and other statistical noise do not considered in calculating the efficiency score, this method may be lose the accuracy of the inefficiency score of the firm. However, DEA is the most applicable method, especially for the service provider sector where the output has mostly measured indirectly as an output-indicator (Coelli et al. 2005). Hence, the Ethiopian Commodity Exchange is among service provider enterprise and its output is measured indirectly as output indicator, this study mainly used this method due to the suitability of the method for such service provider institutes.

According to (Coelli et al. (2005), the inclusion of price data is used to make an aggregate value of various agricultural commodities as a single output indicator. Once multi-outputs have aggregated into a single output indicator, Output-oriented Revenue Maximizing functional form is the most suitable assumption for specification of DEA models for performance analysis of ECX authority. For the fact that the model is specified as Output-oriented Revenue Maximizing function, the traditional DEA analysis result that is reported as CRS_TE (Constant Returns to Scale) score, which corresponds to an Overall Revenue Efficiency. In addition, Allocative Efficiency can be calculated as the ratio of Overall Revenue Efficiency (CRS_TE) to Technical Efficiency (VRS_TE). For Output-oriented efficiency analysis the revenue maximizing function is appropriate to specify the DEA method for our data set. In order to specify the Output-oriented revenue maximizing DEA model, first the Constant Returns to Scale (CRS) should be specified.

Let consider K inputs for N number of DMUs and the vector of K inputs and Y output can be represented by X_i and Y_i for all DMUs. The input matrix can be expressed as $K\ x\ N$ and the output Y matrix for one output is $N\ x\ 1$. Therefore the mathematical representation for CRS model specification is:

$$\begin{aligned} Max_{\ \lambda\ y_i} \theta = {} & P_i'\ q_i^* \\ Subject\ to\text{:} \quad & -q_i^* + Q\lambda \geq 0 \\ & \mathrm{X_i} - \mathrm{X}\lambda \geq 0 \\ & \lambda \geq 0 \end{aligned} \tag{4.3}$$

Where λ is $N\ x\ 1$ vector of constraints, and θ is the scaler; the value of $1/_\theta$ is the score of efficiency of the i^{th} DMUs. However, this specification assumption is for CRS or when the DMUs operate at their optimal scale. If the DMUs are operated below the optimal scale, the measure of technical efficiency is applied, which can be expressed as Variable Returns to Scale (VRS) score. This can be specified by adding the convexity constraint $N\ 1'\lambda = 1$ to the CRS equstion and the VRS of the DEA model is specified as:

$$\begin{aligned} Max_{\ \lambda\ y_i} \theta = {} & P_i'\ q_i^* \\ Subject\ to\text{:} \quad & -q_i^* + Q\lambda \geq 0 \\ & \mathrm{X_i} - \mathrm{X}\lambda \geq 0 \\ & N\ 1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \tag{4.4}$$

Where: P_i' is an input price vector for i^{th} DMUs and q_i^* a revenue maximizing vector of output for i^{th} DMUs. In output-oriented efficiency model, the allocative efficiency used to indicate how the output-mix is efficient to earn the maximum revenue. This can be expressed as a ratio of Revenue Efficiency to Technical Efficiency.

$$Allocative\ Efficiency\ (AE) = \frac{Revenue\ Efficiency\ (RE)}{Technical\ Efficiency\ (TE)} \tag{4.5}$$

This efficiency score shows the level of success that the output-mix is efficient to earn the maximum revenue.

4.5 Inefficiency Effect Model For Both SFA and DEA

The inefficiency effects or the major determinants of efficiency could be estimated in both SFA and DEA methodologies, but the procedure applied for this approach is different.

Stochastic frontier analysis (SFA): - the identification of determinants of efficiency in SFA method could be applied in two ways. As pointed out by Greene (2008), the former literatures apply two-step procedure for performance analysis: first, the stochastic frontier production function has estimated and then firm specific technical inefficacies (Ui) will be predicted. Then in the second step, the predicted technical inefficacy score has used as a dependent variable to regress against the inefficiency variables for identifying the significant inefficiency effects. However, such two stage procedure has criticized by Reifschneider and Stevenson (1991), Kumbhakar et al. (1991) and Wang and Schmidt (2002). These criticisms were due to the inconsistency of the assumption for inefficiency term in both specifications. In the first stage, the frontier uses the assumption that the inefficiency of firms is identical and independently distributed for estimating the frontier. However, in the second stage, the predicted inefficiency score (U_i) regressed against the vector of potential inefficiency effects (Z_i') and hence the first stage assumption of inefficiency term has violated unless all the inefficiency effect coefficients (δ) are equal to zero.

As a solution for the above critics the more applicable one-step maximum likelihood estimation methodology has been suggested by Kumbhakar et al. (1991) and Huang and Liu (1994). This methodology of performance analysis incorporates the technical inefficiency effects model in to *translog* stochastic frontier production function analysis, which uses all parameters together. This includes the estimation of the logarithms of inputs and the inefficiency effects at the same time and the specification is given as equation 4.2.

Data Envelopment Analysis (DEA): identification of the major influential determinants in DEA approach can be analyzed using two-stage procedure. The STATA software reports CRS_TE (CCR model) and VRS_ET (BCC model) scores, these two model uses their own corresponding *theta* (θ) value or efficiency score as a dependent variable for regressing against the inefficiency variable. Since the *theta* is one sided non-negative dependent variable, the Tobit regression model is the best fit for identifying the influential efficiency determinants (Lee et al. 2009).

Chapter Five: Study result and discussion

5.1 Descriptive Statistics

5.1.1 Inputs Used

The inputs used in this performance analysis categorized as Labor, Capital Depreciation, Office and Warehouse Rent and Others Inputs, which comprises the stationary material cost, utility bill, energy, and weighbridge service cost. The four pillars of inputs used with their percentage share of ECX over the last five years has shown as follows:

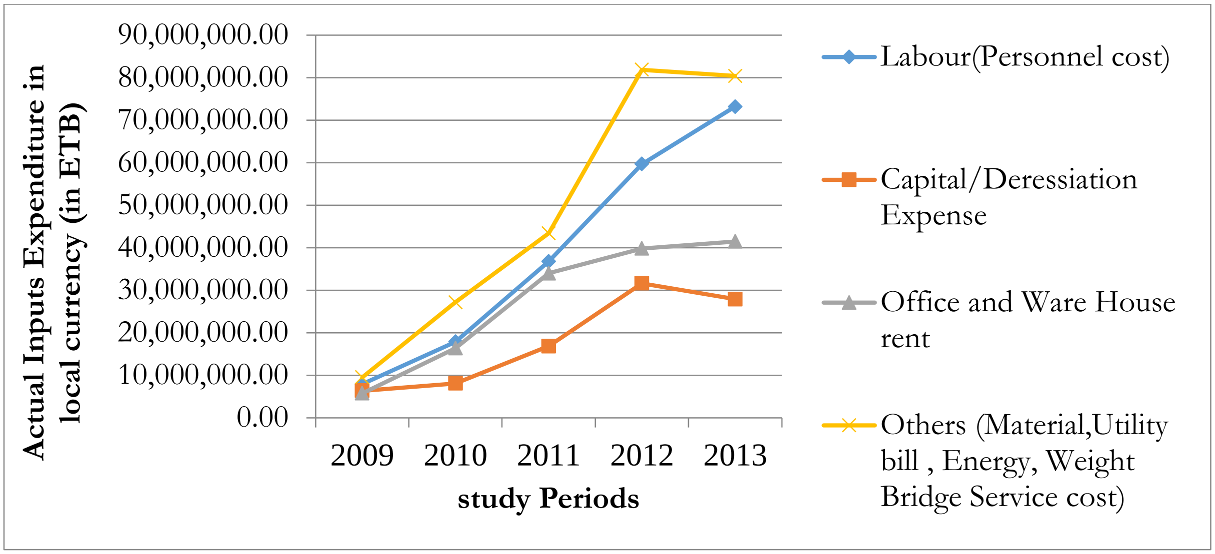
Table 5. 1 The Proportionate Share of Input Used for Ethiopian Commodity Exchange Authority

Input expenditures per year in percentage (%)					
	2009	**2010**	**2011**	**2012**	**2013**
Labor(Personnel cost)	26.8	25.7	28.1	28	32.8
Capital/Depreciation	21.5	11.7	12.9	14.9	12.5
Office and WH rent	19.5	23.5	26	18.7	18.6
others	32.2	39.1	33.1	38.4	36.1
Total	100	100	100	100	100

Own computation: 2014, Percentage share of input used by ECX from 2009 to 2013

Based on the input data summarized above, the share of labor cost is increasing from 26.8 % in 2009 to 32.8 % in 2013, the percentage share allocated for the input category nominated as 'Others' comprises the largest share, which reached the peak percentage share of all inputs in 2010, which is 39.1 % and the lowest share is 32.2 % in 2009. The capital depreciation for fixed asset service used for all Decision Making Units (DMU's) covers the smaller share on average throughout the last five years. Depreciation expense attains the maximum percentage share of all inputs in 2009, which is 21.5 % and the minimum share is 11.7 % in 2010. The actual annual budget allocated for ECX in local currency for consecutive five years for facilitating trading process is graphically illustrated below.

Figure 5. 1 Actual Inputs Allocated from 2009 to 2013 in Local Currency (ETB[6])



Own computation: 2014

The actual increments of budget allocation for each category of input can be easily visualized in figure 5.1 than the above percentage share of each input expenditure over the last five years. This is quite crucial for comparing with the trend of mean efficiency for the study period that will be discussed latter. This data set indicates that the input category nominated as 'Others' has risen tremendously until 2012 and then get decreasing for the last one year. But the trend of labor cost (Personnel expense) input category still displays an increasing trend and the rest input categories Capital Depreciation and Rents have almost similar trend in the study period. In addition the descriptive statistics of all inputs are summarized as follows:

Table 5. 2 Descriptive Data for Inputs Used

Variable	obs	Mean	Std.Dev.	Min	Max
Lab	85	2,299,846	1,715,422	12,895	6,972,953
Cap	85	1,069,117	1,015,414	6,897	3,748,496
Rent	85	1,618,272	1,167,767	64,512	4,127,588
OM	85	2,851,793	2,140,137	11,671	7,967,438

Own computation: 2014, the input value of this descriptive statistic is in Ethiopian Birr (currently 1 Euro=25. 66 ETB on 17/10/2014)

[6] ETB represents the local currency and that stands for Ethiopian Birr, which officially exchanged as: 1 Euro = 26.71 on Aug 03/2014).

5.1.2 Output-Indicators

ECX engaged in facilitating the exchange of six agricultural commodities such as Green Mung Bean, Maize, White Coffee, Pea Bean and Sesame. The first three commodities are mainly traded for local processors and wholesalers. The latter three commodities, namely Coffee, Pea Bean and Sesame are mainly exchanged for the export market and constitute more than 99 % of the total quantity of commodities exchanged. These three commodities are the major foreign currency earner for the country and exporting these commodities could not be possible without passing through the ECX trading floor. Hence improving the operational efficiency of ECX to boost the inflow of these commodities means that exactly improving the country's revenue earnings from foreign market.

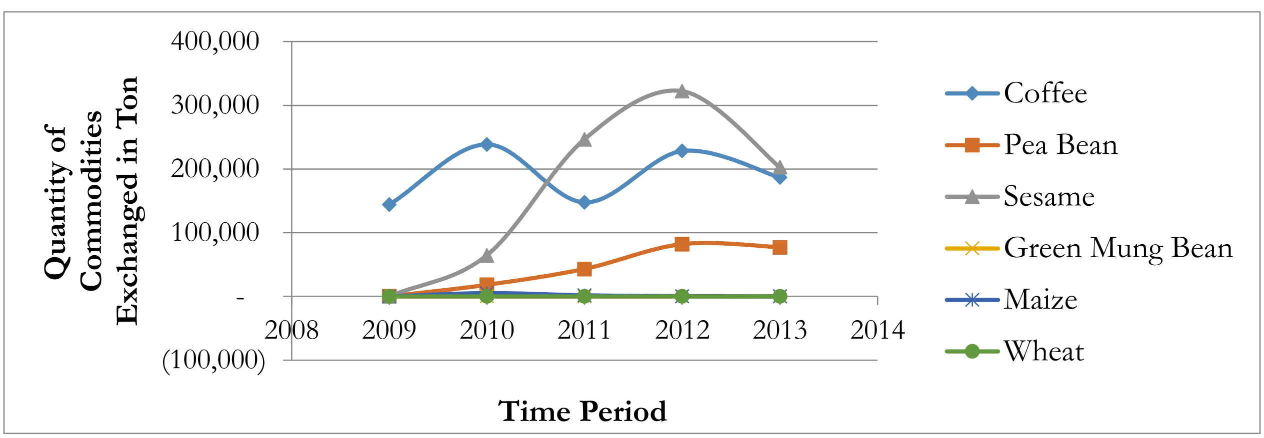
Table 5. 3 The Quantity of Commodities Exchanged (in Ton) Per Year and Their Percentage Share

	Minimum	Maximum	Sum	Mean	Std. Deviation
Coffee	144,065.00	238,761.00	945,549.00	189,109.80	44,003.73
Sesame	80.00	322,322.00	836,545.00	167,309.00	132,392.48
Pea Bean	-	81,866.00	220,097.00	44,019.40	35,812.21
Maize	-	5,257.00	7,483.00	1,496.60	2,224.75
wheat	-	32.00	37.00	7.40	13.92
Mung Bean	-	-	-	-	-

Own computation: 2014

This actual data set discloses the standard deviation of the Sesame is the highest because its increment within the last five years is very high and the range is also very wide. The data for Mung Bean is zero for the study period, but it has some small quantity at the beginning of 2008,which is not included in this study.

Figure 5. 2 Real Term Trends of Agricultural Commodities Exchanged in Ton



Own Computation: 2014

This real term data set discloses that the aim of establishing ECX by the government seems to give a convenient marketing pattern for the flow of exported major agricultural commodities and the exchange of non-exported agricultural commodities have totally neglected in the system, which constitutes less than 1% on average for the last five years. Coffee and Sesame constituted the largest share in the exchange process.

Table 5. 4 Output Indicators Descriptive Statistics in Ton

Commodities	2009	2010	2011	2012	2013
Export Commodities in Ton	144,145.00	321,560.00	437,533.60	632,473.00	466,479.00
Export Commodities in %	99.99%	98.39%	99.59%	99.93%	99.99%
Non-Export Commodities in Ton	20.00	5,262.00	1,784.00	422.00	32.00
Non-Export Commodities in %	0.01%	1.61%	0.41%	0.07%	0.01%

Own computation 2014:

The aggregate quantity of export commodities is increasing greatly from 144,145 tons in 2009 to 466,479 tons in 2013. The exported commodities constitute more than 99 % for the last five years on average.

5.2 Efficiency Score Analysis Using DEA and SFA Models

5.2.1 Data Envelopment Analysis (DEA)

Firms' objective could be either cost minimizing for producing a given level of output or profit/revenue maximizing by keeping the input level constant. The choice between these objectives determines the STATA software analysis options to select either Input-oriented or Output-oriented command for performance analysis. Since the Ethiopian Commodity Exchange (ECX) is not a producing firm rather it is a trade facilitating service provider, the most appropriated proxies of output indicator is the value of aggregated commodity that has been exchanged in the ECX trading floor for the last five years. This study used Output-oriented DEA model, where the plausible assumptions are: i) The Revenue Maximizing DEA model appropriately use the Output-oriented option of STATA command and, ii) This study assumes that all the produced commodities across the country are not delivered to ECX for exchange and thus ECX could maximize the inflow of agricultural commodities by removing the inefficiency determinants (effects) while keeping the level of input constant. Using the STATA software, DEA approach reports different efficiency scores in three basic columns. The first component of DEA is known as CCR model, which is originally named after the work of Charnes et al. (1978). CCR model is reported in STATA software as CRS_TE (Constant Returns to Scale-Technical Efficiency), which estimates the Overall Efficiency (in this study it is a Revenue Efficiency) of DMUs. CRS_TE estimation of DEA model in the STATA software represents the product of the Scale Efficiency and the Technical Efficiency of the firm. The second component is the BCC model that has introduced by Banker et al. (1984), which used to estimates the Technical Efficiency alone by segregating from the Scale Efficiency component. The BCC model of efficiency in the STATA software package is reported as VRS_TE (Variable Returns to Scale Technical Efficiency) estimation, which is exactly corresponds to the estimation of the True Technical Efficiency of the DMU's. The third component is the Allocative Efficiency score, which is the ratio of CRS_TE to VRS_TE in Output-oriented efficiency model, which indicates the output-mix efficiency to earn maximum revenue for the country (Coelli et al. 2005)

Table 5. 5 The Overall Revenue (CRS_TE), the Technicefficienciesand Allocative efficeincies of ECX

Location (DMUs)	*Revenue efficiency (CRT_TE) in %*					*Mean Rev.Effi.*	*Technical Efficiency (VRS_TE) in %*					*Mean Tech.Effi.*	*Mean Alloc.Effi.*
	2009	*2010*	*2011*	*1012*	*2013*		*2009*	*2010*	*2011*	*1012*	*2013*		
Addis Ababa	0.51	0.61	0.58	0.59	0.50	**0.56**	0.52	0.62	0.61	0.62	0.58	**0.59**	**0.95**
Adama	0.00	0.88	1.00	0.39	0.27	**0.64**	0.00	1.00	1.00	0.54	0.28	**0.70**	**0.92**
Assosa	0.00	0.23	1.00	0.29	0.03	**0.39**	0.00	0.23	1.00	0.34	0.04	**0.40**	**0.94**
Bedelle	0.70	0.50	0.67	0.70	0.37	**0.59**	0.71	0.50	0.70	0.73	0.39	**0.61**	**0.97**
Bonga	1.00	0.59	0.63	0.69	0.70	**0.72**	1.00	0.59	0.63	0.70	0.83	**0.75**	**0.96**
Bure	0.01	0.38	1.00	0.58	0.55	**0.50**	0.01	0.39	1.00	0.59	0.57	**0.51**	**0.98**
Dire Dawa	0.70	0.82	0.81	0.45	0.22	**0.60**	0.71	0.82	0.82	0.45	0.24	**0.61**	**0.98**
Dilla	0.69	0.63	0.70	0.68	0.36	**0.61**	0.70	0.63	0.71	0.68	0.37	**0.62**	**0.99**
Gimbi	0.62	0.71	0.61	1.00	0.43	**0.67**	0.63	0.71	0.61	1.00	0.49	**0.69**	**0.97**
Gonder	0.00	0.44	0.77	0.54	0.54	**0.57**	0.00	0.45	0.77	0.55	0.54	**0.58**	**1.00**
Hawassa	1.00	0.74	1.00	0.80	0.63	**0.83**	1.00	0.75	1.00	0.80	0.65	**0.84**	**0.99**
Hummera	0.00	1.00	0.96	0.77	0.85	**0.89**	0.00	1.00	1.00	0.77	1.00	**0.94**	**0.96**
Jimma	1.00	0.91	0.87	0.94	0.34	**0.81**	1.00	0.91	0.89	0.95	0.36	**0.82**	**0.98**
Kombolcha	0.00	0.20	0.04	0.13	0.23	**0.15**	0.00	0.21	0.04	0.16	0.32	**0.18**	**0.89**
Metema	0.00	0.83	0.79	0.61	0.82	**0.76**	0.00	0.90	0.80	0.63	0.86	**0.80**	**0.97**
Nekemte	0.01	0.19	1.00	0.72	0.47	**0.48**	0.01	0.20	1.00	0.87	0.72	**0.56**	**0.88**
Sodo	0.32	0.66	0.71	0.54	0.25	**0.49**	0.35	0.67	0.72	0.67	0.37	**0.55**	**0.87**
Mean (%)	**0.60**	**0.61**	**0.77**	**0.61**	**0.44**	**0.60**	**0.60**	**0.62**	**0.78**	**0.65**	**0.51**	**0.63**	**0.95**

Own Computation: 2014.

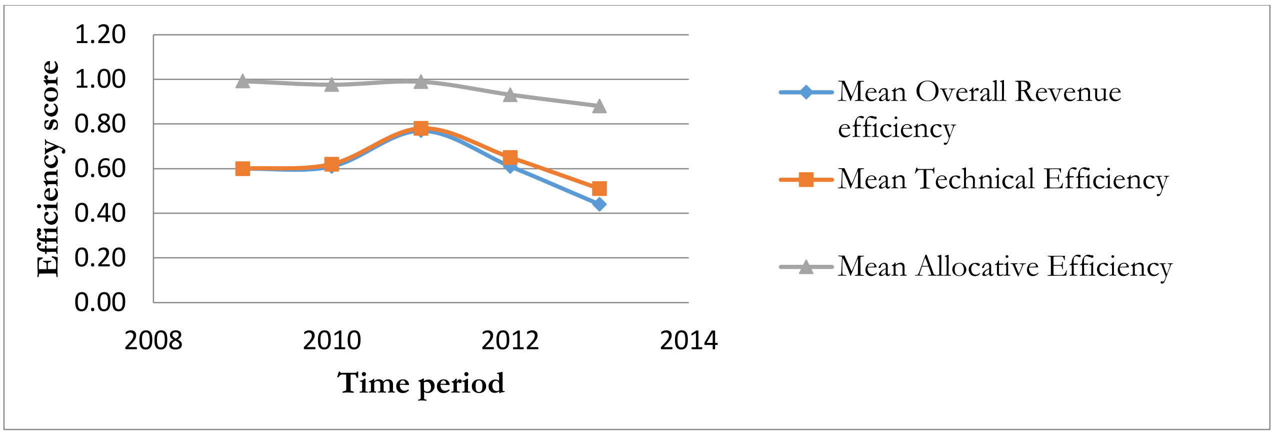
Overall Revenue Efficiency (CRS_TE) of ECX: - this efficiency score indicates the sum of Scale and Technical Efficiency of individual Decision Making Units (DMUs) of ECX. The DEA analysis result indicates that the mean Overall Revenue Efficiency score for the year 2009 to 2013 is 60 %. This revered that with a given quantity of input combination, the country's forgone revenue from exporting these agricultural commodities for the last five years is 40 % of the total revenue earned in the period. In other word, ECX could be possible to achieve an extra 40 % of the total revenue for the country from exporting Coffee, Pea Bean, and Sesame with in the last five years. The minimum mean Overall Revenue Efficiency throughout the last five years is 44 % in 2013 and the maximum score is 77 % which is in 2011. The minimum Overall Revenue Efficiency score can be interpreted as: with the given level of input combinations, the country has already sacrificed 56 % of the total revenue that could be earned from exporting these three agricultural commodities in 2013. The lowest Overall Revenue Efficiency achievement has registered for *Kombolcha* location and the highest revenue success has recorded for *Humera* location, which is about 15 % and 89 % respectively.

Technical Efficiency (VRS_TE): - The concept of frontier is quite crucial to know whether the firm is technically efficient or not, because the firms' technical efficiency is measured as a relative distance from the frontier. The given DMU is said to be technically efficient when the technical efficiency score is one and the slack of output is zero in output-oriented efficiency model. The Technical Efficiency in STATA software can be given as VRS_TE and represents a "True Technical

Efficiency" scores, which excludes the scale efficiency (Lee et al. 2009). The maximum mean Technical Efficiency score in the table 5.5 is 78 % and the minimum score is 51 % in the years 2011 and 2013 respectively. This reveals the output that has exchanged on ECX floor could have been possible to increase by 22 % for the year 2011 and 49 % for the years 2013, without demanding an extra input for the corresponding fiscal years. When we compare the level of technical efficiency across all the DMUs, the maximum technical efficiency score is 94 % and the minimum score is 18 % for the *Humera* and *Kombolcha* DMUs respectively.

Allocative efficiency: - The Allocative Efficiency score shows the efficiency level of Output-mix to earn maximum revenue in the case of Output-oriented DEA model (Coelli et al. 2005). In this regard the ECX has much better achieved in choosing the best combination of the output mix of commodities which provides higher revenue. The mean Allocative Efficiency score for the last five years is 95 %, which shows the allocative inefficiency is only 5 % to get maximum revenue, but still the ECX has lost 5% of the total Revenue due to an improper mix of output in the last five years.

Figure 5. 3 Graphic Representation of Overall Revenue, Technical and Allocatice efficiency of the ECX



Own Computation 2014,

This figure shows that during the first three years (from 2009 to 2011) the Allocative efficiency was very good because the ratio of Revenue Efficiency to Technical Efficiency is near to one. After 2011 the Allocative Efficiency of ECX, which indicates the mix of output to earn maximum revenue for the country became worse. Therefore the difference between Revenue Efficiency and Technical Efficiency became widened in 2013. The gap between the Revenue Efficiency and Technical Efficiency is equivalent to the amount by which the Allocative Efficiency is decreasing. In general all the Revenue, technical and allocative efficiencies of the ECX have been in a better position in 2011. After this peak point the decrease in Allocative Efficiency of ECX causes the variation between the Revenue Efficiency and Technical Efficiency of ECX. In addition, the trends of both Revenue and Technical efficiencies by themselves are getting wore in 2013.

5.2.2 Stochastic Frontier Production Function

Before estimating the Stochastic Frontier Analysis (SFA), one must conduct two fundamental standard Likelihood Ratio statistical tests. First the Likelihood ratio test to choose between the two functional forms: the Cobb-Douglas or Translog production frontier. Secondly, there must be conduct another Likelihood Ratio test to confirm the existence of influential inefficiency effects (determinants).

5.2.2.1 Hypothesis Testing

The first procedure for SFA is to choose the functional form of stochastic frontiers: *Cobb-Douglas* production function and *Translog* production functions. The *Cobb-Douglas* functional form is estimated by using the logarithm of output and inputs using *"sfpanel"* STATA command, where the square and the cross–products of inputs are equal to zero. The null hypothesis for this Likelihoods Ratio test (LR) is that the *Cobb-Douglas* functional form is appropriate for the performance analysis. The value of Likelihood Ratio (LR) test determines whether the *Cobb-Douglas* or *Translog* functional form model is the best fit for the given data set. In this study the value of likelihood ratio test expressed by chi-square with ten degrees of freedom (represents the number of interaction term and squares of inputs). The null hypotheses that prefer the *Cobb-Douglas* functional form has rejected using the traditional chi-square test value of 104.42 that is significant even at the 5 % level of significance. Hence we can conclude confidently that the *Translog* functional form is preferred to the *Cobb-Douglas* functional form for the performance analysis of this data set. Secondly, we need to test whether the inefficiency is coming from random error or inefficiency effects (operational determinants). This can be revealed by looking at the value of γ (gamma), which is calculated by dividing the inefficiency variation to the overall variation$(\gamma = \frac{\sigma_{ui}^2}{\sigma_{ui}^2+\sigma_{vi}^2})$. The null- hypothesis for this test is that $\gamma = 0$ or it can be expressed as all the inefficiency effects are equal to zero ($H_0 = \delta_1 = \delta_2 = \delta_3 = \delta_n = 0$). Accepting the null hypothesis means OLS is more appropriate model for performance analysis of this data set, because the whole variation of the error term is coming from statistical noise and the inefficacy effect variation is equal to zero. But rejecting the null hypothesis confirms the existence of operational inefficiency in ECX. In this study the chi-square value of Log likelihood ratio test is 62.07. This indicates the null hypothesis is rejected even at 5 % significance level with 10 degrees of freedom. The rejection of the null hypothesis confirms that this data set suitably analyzed by using the SFA method than the OLS model.

Table 5.6 Inefficiency Effect Model in Translog Stochastic Frontier and Data Envelopment Analysis

Coefficients	Inputs	***InOUTP dependent*** (1) Translog Frontier Model	$\boldsymbol{\theta}$ ***(theta dependent)*** (2) Tobit Model for DEA
β_1	InLab	8.852**	
		(3.994)	
β_2	InCap	-1.588	
		(1.616)	
β_3	InRent	-5.740	
		(4.531)	
β_4	InOM	2.693	
		(2.675)	
β_5	InLab2	-0.0279	
		(0.567)	
β_6	InCap2	0.0998	
		(0.0667)	
β_7	InRent2	0.454	
		(0.296)	
β_8	InOM2	0.978**	
		(0.453)	
β_9	InLab_InCap	0.555**	
		(0.268)	
β_{10}	InLab_InRent	0.155	
		(0.622)	
β_{11}	InLab_InOM	-1.160	
		(0.937)	
β_{12}	InCap_InRent	-0.0933	
		(0.168)	
β_{13}	InCap_InOM	-0.514**	
		(0.221)	
β_{14}	InRent_InOM	-0.530	
		(0.485)	
	Inefficiency effects		
δ_1	VAISTdum1	0.110	0.0834
		(0.105)	(0.0677)
δ_2	WHLCsdum1	-0.200*	-0.0453
		(0.106)	(0.0649)
δ_3	UBLECXdum1	-0.511***	-0.0621
		(0.190)	(0.0879)
δ_4	ASSYINdum1	-0.578***	-0.145**
		(0.133)	(0.0705)
δ_5	AVGCsdum1	-0.0174	-0.0852
		(0.110)	(0.0679)
δ_6	LLRCsdum1	-0.694***	-0.326***
		(0.171)	(0.0781)
	Constant	-4.147	0.781***
		(89.31)	(0.117)
	Sigmma	-1.457***	0.290***
		(0.242)	(0.0244)
	Gamma	-0.0426	
		(0.584)	
	Mu (Mean Inefficiency)	18.46	
		(85.65)	
	Observations	85	85
	Number of dmu	17	17

*Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

The inefficiency effect model of SFA model output shows that the value of γ is 0.0426, which means only 4.26 % of the ECX operational inefficiency is coming from the inefficiency effects and the random error contributes about 95.74 % of the composite error term. Based on the above one stage inefficiency effect estimation, the SFA model provides the mean technical inefficiency (Mu) score for ECX from 2009 to 2013 is 18.46. In other word the mean technical efficiency score using the SFA model is 81.54 % (1-Mu). The number of significant determinant variables in the SFA model is four in number. However, only two independent variables are significant in Tobit regression model under DEA approach.

5.3 Efficiency Score Comparison Between SFA and DEA Models Efficiency Estimations.

The mean Technical Efficiency in SFA is corresponds to the mean VRS_TE score in DEA model, which scores 81.54 % and 63 % respectively. The range of estimated technical efficiency in the SFA model is inflated and very narrow in this study, which is consistent with other studies (see: Hjalmarsson et al. 1996, Reinhard et al. 2000) . Since the stochastic frontier production function requires various distributional assumptions, it is not good for a small number of data set. Hence the DEA model could provide a more credible efficiency score for the performance analysis of this data set.

Table 5. 7 Comparisons between SFA and DEA models efficiency estimations

	SFA estimation	***DEA estimation***	
DMUs	*Mean Technical Efficiency (%)*	*Mean CRS_TE*	*Mean VRS_TE*
Addis Ababa	81.76	0.56	0.59
Adama	81.70	0.64	0.70
Assosa	81.37	0.39	0.40
Bedelle	81.96	0.59	0.61
Bonga	82.07	0.72	0.75
Bure	82.35	0.50	0.51
Dire Dawa	82.02	0.60	0.61
Dilla	81.80	0.61	0.62
Gimbi	82.04	0.67	0.69
Gonder	82.36	0.57	0.58
Hawassa	82.07	0.83	0.84
Hummera	82.07	0.89	0.94
Jimma	82.27	0.81	0.82
Kombolcha	81.17	0.15	0.18
Metema	82.15	0.76	0.80
Nekemte	82.22	0.48	0.56
Sodo	81.98	0.49	0.55
Mean Efficiency of ECX	81.54	0.60	0.63

Own computation: 2014

5.4 Representative Efficiency Model Determination

This study estimates the efficiency score and the major significant determinants in both models. However, the results of these models are quite different in terms of efficiency scores and number of significant determinant variables. Therefore, we need to stick to one of the best and appropriate model based on the priory theoretical aspects. The comparison between SFA and DEA in the section mentioned in 4.4.1 elaborates that the DEA model is more appropriate if:

i. The sample size of the data set is smaller
ii. The output is measured indirectly as an output indicator particularly for service provider industries.

Because of these two fundamental theoretical rationales, this study sticks to DEA model output for its suitability and reliability of the estimator regarding to ECX data set. Thus the DEA model analysis result can be a representative for the efficiency score of ECX and one can confidently refer that the Revenue, Technical and Allocative efficiencies of ECX is 0.60, 0.63 and 0.95 present respectively. Moreover, based on DEA model analysis only two independent variables nominated as "*ASSYIN*" and "*LLRC*" are significantly affecting the Overall Revenue Efficiency of the ECX market.

Inefficiency effects in DEA model: - The Tobit regression has been used for identifying the significant determinant variable that affects the inefficiency of the ECX. The dependent variable that has been used in Tobit model is the value of CRS_TE, which is represented by non-negative truncated score -*Theta* (θ) - for identifying the significant determinants. The analysis result of the Tobit model revealed that only two independent variable that nominated as "*ASSYIN*" and "*LLRC*" are significantly affecting the operational efficiency of the ECX.

The dummy variable termed as *ASSYIN* is used to capture the effects of deteriorating the commodity price at ECX trading floor due to an informal asymmetric market information provided to buyer's from various warehouse locations. This variable affects the influx of agricultural commodities at less than 1 % ($p<0.01$) significance level. The possible justification for these significant variables is that buyers have their own representative in most of the warehouse location. The explicit reason is that for facilitating the transfer of ownership at the warehouse soon after the trading process. However, these employees informally collect pieces of information about the expiry date of the commodities from the warehouse officers which is already fixed by the ECX. If suppliers don't sell their commodities that are stored in the warehouse within the certain day limit (for instance the current expiry date of coffee is 20 days), the rule of ECX compelled them to pay an extra 3.5 % commission per sell of each commodity. Buyers informally identify the expiry date of the agricultural commodities stored in various warehouse locations through their representatives that increases buyer's bargaining power to cut the price for the commodities their expiry date is coming to an end shortly. This asymmetric information released informally from different warehouse locations discourages the suppliers to work with ECX and negatively affect the inflow of agricultural commodities to ECX.

The other significant variable is termed as *LLRC*, which is a dummy variable that used to capture how the lower limit criteria of ECX affect the delivery of various commodities to ECX. The minimum quantity of the agricultural commodities that could be delivered to the ECX's warehouse is already fixed for all commodities, for instance the minimum amount that has to be delivered to the warehouse for Coffee is thirty quintals. Due to this lower limit criteria of ECX large quantity of agricultural commodities are exchanged locally that reduces the aggregate quantity of output brought to the ECX's marketing channel. The DEA result revealed that the variable termed as "LLRCs" negatively affects the quantity of output-indicator at less than 1% significance level and the direction of coefficient is consistent with the hypothesized sign.

Chapter 6: Conclusion

Establishing the Ethiopian Commodity Exchange (ECX) is the key intervention to bring buyers and sellers together that improves the effectiveness of the grain market and enlarge the contribution of the agricultural commodity market for the country's economic development. It is a timely market facilitating institution to provide standardized and graded agricultural commodities for the export and local processers (Gabre-Madhin 2006). Proper functioning of the commodity exchange marketing system could have an immense role in strengthening the bargaining power of the producers in price negotiations and it could also benefit producers based on the quality and quantity of their supply. This could be an incentive for producers to boost on-farm agricultural production not only in volume, but also it helps to improve the quality of their produce as well (Kamara 2004),

This study uses both SFA and DEA efficiency models to investigate the efficiency level of the ECX, because there is no statistical method to choose one model over the other. However, the DEA is more trustworthy for this data set due to two fundamental theoretical background: i) as the sample size of the data set is small and ii) the firm being evaluated is categorized as service provider industry and the output is measured indirectly as output-indicator rather than manufacturing or industrial firms, which produces tangible products such as car, soap and so on. Therefore, based on these theoretical contexts, the DEA model output for the estimation of Overall Revenue, Technical and Allocative efficiencies are more reliable than the SFA model for this data set.

Given the data set and the profile of the ECX, it is the only authorized market channel through which Coffee, Pea Bean and Sesame trading are taking place, which constitutes more than 99 % of the total commodity trading in the ECX trading floor. Though it provides the priority for these high value exported agricultural commodity, but still there will be a long way to explore all the potential areas of these high value crops growing areas of the country. Any improvement of operational efficiency that increases the influx of these major exported agricultural commodities to the ECX has a direct positive impact on the country's revenue from the export market. The actual value of Output exchanged and the input used for facilitating this marketing operation throughout the study period have more or less an increasing trend for the last five years (from 2009 to 2013). However, the DEA model reveals that the trend of the Overall Revenue, the Technical Allocative efficiencies have a shape of downward parabola and the efficiency reached its maximum in 2011. Unless the efficiency will be improved by removing the significant determinants, which are inhibiting rules and regulations of the commodity exchange, the forgone revenue earned from exporting the major agricultural commodities such as Coffee, Sesame and Pea Bean would increase by the amount of Overall Revenue inefficiency score every year. According recent World Bank report, these agricultural commodities are the major revenue earner in terms of foreign currency and constitutes a share of 51.54 % of the whole Ethiopian export market(World Bank 2014). Hence the country's economy could be affected tremendously if the operational efficiency of ECX will remain declining as a current efficiency trend.

Finally, this study is mainly concentrated on internal operational efficiencies and determinants of The Ethiopian commodity Exchange (ECX). The trend of the efficiencies is getting worse in recent years. Therefore, this young marketing institution requires further holistic study on identifying potential determinants that encompasses internal, external and policy environments to improve the efficiency of the transaction processes. Moreover, the study on Market Efficient Hypothesis (MEH) of export agricultural commodities is quite crucial to explore how the information flow from various dimensions affects the price of the agricultural commodities at ECX trading floor.

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Appendixes

Appendix A: DEA model output

Appendix A. 1 DEA Model outputs

VRS Frontier(-1:drs, 0:crs, 1:irs)

DMUs	CRS_TE	VRS_TE	NIRS_TE	SCALE	RTS
dmu:1	0.512532	0.515241	1.000000	0.994742	1.000000
dmu:1	0.614222	0.615057	0.628532	0.998643	1.000000
dmu:1	0.584380	0.610424	1.000000	0.957336	-1.000000
dmu:1	0.586056	0.615908	1.000000	0.951531	-1.000000
dmu:1	0.501850	0.581088	1.000000	0.863638	-1.000000
dmu:2	0.000000	0.000000	0.000000	1.000000	0.000000
dmu:2	0.883189	1.000000	1.000000	0.883189	1.000000
dmu:2	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:2	0.394602	0.537772	1.000000	0.733771	1.000000
dmu:2	0.271348	0.282154	1.000000	0.961705	1.000000
dmu:3	0.000000	0.000000	0.000000	1.000000	0.000000
dmu:3	0.227183	0.231927	1.000000	0.979546	1.000000
dmu:3	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:3	0.291355	0.336714	0.423449	0.865289	1.000000
dmu:3	0.034490	0.040354	0.042893	0.854683	1.000000
dmu:4	0.697080	0.707558	1.000000	0.985191	1.000000
dmu:4	0.501887	0.502184	0.503315	0.999408	1.000000
dmu:4	0.673455	0.695549	0.702439	0.968236	1.000000
dmu:4	0.702071	0.734181	1.000000	0.956264	-1.000000
dmu:4	0.369817	0.387136	0.391835	0.955265	-1.000000

dmu:5	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:5	0.585714	0.586512	1.000000	0.998639	1.000000
dmu:5	0.628479	0.631003	1.000000	0.995999	1.000000
dmu:5	0.693086	0.704176	0.708944	0.984251	-1.000000
dmu:5	0.697582	0.833088	1.000000	0.837345	-1.000000
dmu:6	0.008647	0.008647	1.000000	1.000000	0.000000
dmu:6	0.379381	0.391578	0.387075	0.968852	1.000000
dmu:6	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:6	0.579023	0.591834	0.602178	0.978354	-1.000000
dmu:6	0.547532	0.571090	1.000000	0.958748	-1.000000
dmu:7	0.695755	0.707561	1.000000	0.983314	1.000000
dmu:7	0.822502	0.823432	1.000000	0.998871	1.000000
dmu:7	0.814607	0.815277	0.976770	0.999178	1.000000
dmu:7	0.452441	0.453115	1.000000	0.998512	1.000000
dmu:7	0.216720	0.236862	1.000000	0.914965	1.000000
dmu:8	0.694244	0.699480	1.000000	0.992515	1.000000
dmu:8	0.629872	0.630017	0.654518	0.999770	1.000000
dmu:8	0.699640	0.713471	0.882835	0.980614	-1.000000
dmu:8	0.675265	0.679871	0.745754	0.993224	1.000000
dmu:8	0.358138	0.365829	0.384481	0.978976	-1.000000
dmu:9	0.624177	0.631297	0.668194	0.988722	1.000000
dmu:9	0.706435	0.707456	0.743271	0.998556	1.000000
dmu:9	0.606153	0.607300	0.684386	0.998112	1.000000
dmu:9	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:9	0.430321	0.493172	1.000000	0.872557	-1.000000

dmu:10	0.000000	0.000000	0.000000	1.000000	0.000000
dmu:10	0.440986	0.445652	1.000000	0.989531	1.000000
dmu:10	0.768132	0.769687	1.000000	0.997980	1.000000
dmu:10	0.544575	0.547995	1.000000	0.993758	1.000000
dmu:10	0.542740	0.542751	1.000000	0.999980	1.000000
dmu:11	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:11	0.743156	0.747341	0.756054	0.994400	1.000000
dmu:11	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:11	0.802781	0.802918	1.000000	0.999829	1.000000
dmu:11	0.627126	0.648386	1.000000	0.967210	1.000000
dmu:12	0.000000	0.000000	0.000000	1.000000	0.000000
dmu:12	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:12	0.956078	1.000000	1.000000	0.956078	-1.000000
dmu:12	0.769892	0.773913	1.000000	0.994804	1.000000
dmu:12	0.851082	1.000000	1.000000	0.851082	-1.000000
dmu:13	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:13	0.911810	0.912225	1.000000	0.999545	1.000000
dmu:13	0.867654	0.885455	1.000000	0.979897	-1.000000
dmu:13	0.938114	0.948230	1.000000	0.989331	1.000000
dmu:13	0.340546	0.363159	1.000000	0.937733	1.000000
dmu:14	0.000000	0.000000	0.000000	1.000000	0.000000
dmu:14	0.200823	0.212724	1.000000	0.944056	1.000000
dmu:14	0.035075	0.035075	0.058480	1.000000	0.000000
dmu:14	0.126940	0.160656	0.238987	0.790134	1.000000
dmu:14	0.231369	0.315933	0.659163	0.732337	1.000000

dmu:15	0.000000	0.000000	0.000000	1.000000	0.000000
dmu:15	0.831660	0.904701	0.857296	0.919264	1.000000
dmu:15	0.793433	0.797826	0.793992	0.994494	1.000000
dmu:15	0.606808	0.625667	1.000000	0.969858	-1.000000
dmu:15	0.824386	0.859083	1.000000	0.959612	-1.000000
dmu:16	0.008486	0.008486	0.010401	1.000000	0.000000
dmu:16	0.187464	0.200213	0.194100	0.936326	1.000000
dmu:16	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:16	0.723603	0.865337	1.000000	0.836210	-1.000000
dmu:16	0.469014	0.721763	1.000000	0.649816	-1.000000
dmu:17	0.318126	0.345221	0.363989	0.921514	1.000000
dmu:17	0.657535	0.666430	0.734760	0.986653	1.000000
dmu:17	0.712996	0.719606	0.745463	0.990815	1.000000
dmu:17	0.536495	0.671508	0.848939	0.798940	1.000000
dmu:17	0.246187	0.365084	1.000000	0.674330	1.000000

Appendix B : Logliklihood Ratio tests

Appendix B. 1 Translog Versus Cobb- Douglas Function Selection test

lrtest Translog_SFA .

Likelihood-ratio test LR chi2(10) = 104.42

(Assumption: . nested in Translog_SFA) Prob > chi2 = 0.0000

Appendix B. 2 Inefficeiency Effect Avaiablity Test

lrtest FULLSFA .

Likelihood-ratio test LR chi2(7) = 62.07

(Assumption: . nested in FULL SFA) Prob > chi2 = 0.0000