FIRM-LEVEL EFFICIENCY IN THE NON-TRADITIONAL EXPORTS SECTOR IN GHANA

BY

ATTA-QUAYSON, ALHASSAN

A THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN ECONOMICS

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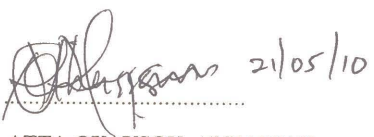
DECLARATION

I, Atta-Quayson Alhassan, hereby do declare that this thesis is entirely my own and that neither part nor whole of it has been presented either in this University or elsewhere.



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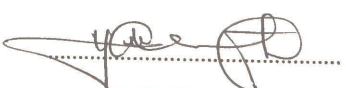
(STUDENT)



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DR. YAW ASANTE

(SUPERVISOR)

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DR. LOUIS BOAKYE-YIADOM

(SUPERVISOR)

DEDICATION

I dedicate this work to two distinguished personalities who conceived my life and have over the time impacted my life considerably. They are Ibrahim Alhassan and Mariam Ibrahim, my parents.

ACKNOWLEDGEMENT

I am tremendously grateful to Almighty Allah, who is also the Most Gracious and Ever Merciful, for my life, particularly over the past two years of my studies. I am very thankful to Allah for my strength and His guidance throughout my studies. For these and other reasons I say Alhamdulillah, All Praise Belongs to Allah.

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For all those who, in diverse and immeasurable ways, contributed to this thesis and I fail to mention for want of space, I say thank you. However, I remain ultimately liable for any lapses that may be associated with this work

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ABSTRACT

The level of efficiency and dynamism of the emerging non-traditional exports sector is important to Ghana's quest to accelerate economic growth in order to achieve middle-income status. The potential of the non-traditional exports sector to break into the dominance of the traditional exports sector and to enhance the diversification of, and deepening of, the total exports sector is observed by stakeholders. This can, however, be achieved if the non-traditional exports sector exhibits an appreciable level of firm-level efficiency.

The study estimates firm-level technical efficiency of NTE sector firms in Ghana using a cross-sectional data of sixty firms. The data, made up of both qualitative and quantitative, were directly collected from the selected firms during a survey conducted for this purpose. The data collected comprised value of annual turnover (sales), annual cost of raw materials, end-of-year book value of fixed assets, annual cost of energy, and annual cost of labour, for the year 2007. The firms also provided information characterizing them as well as their export and/or non-export operations.

The study fits Cobb-Douglas and Translog functional forms of production to the data collected. Based on the Likelihood Ratio Test, it was ascertained that the Cobb-Douglas fit the data better than the Translog. Technical efficiency scores were estimated and regressed on firm specific variables to identify those that influence efficiency in the NTE sector. These efficiency scores, in terms of percentages, ranged from as little as 34 per cent to 95 per cent, and averaged 80 per cent. This implies that the NTE sector firms are efficient.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The level of efficiency and dynamism of the emerging non-traditional exports sector is important to Ghana's quest to accelerate economic growth in order to achieve middle-income status. The middle-income status which is thought to be characterized by a per capita income of at least US$1000 is to be achieved by the year 2015, within a decentralized democratic environment (GPRSII). In accordance with this overarching goal, emphasis is placed on the diversification of, and increase in, the export base so as to change the structure of the economy. This is to be achieved through the promotion of new areas of competitive advantage in the export sector and the economy at large, taking full advantage of Preferential Access to markets such as those supported by the African Growth and Opportunity Act (AGOA) in the United States of America (USA). The other preferential access is the African Caribbean Pacific (ACP) – European Union (EU) market (though the Non-Reciprocal Arrangements are being converted to reciprocal ones in the case of the ACP-EU). The Government of Ghana also aims at a full engagement in multi-lateral trade negotiations (GPRSII).

The need to diversify away from the gold-cocoa-timber structure is broadly agreed on by many Ghanaians. The cocoa-gold-timber structure is thought of as the three dominant primary products that together fetch the country about 75 per cent of her export earnings. The move to diversify the export base is expected to address the economy's vulnerability that

results from persistent reliance on the export earnings of those primary commodities. The establishment of the Ghana Export Promotion Council (GEPC) in 1969 as an agency at the Ministry of Trade and Industry was a move towards exploring avenues for diversification and enhancing efficiency of firms. The focus of the Council has primarily been the diversification of the country's export base. Besides the GEPC, a number of industrial and trade supporting institutions have been set up to provide support to the export sector. Some of these institutions include the Association of Ghana Industry, Ghana Investment Promotion Centre, Export Development and Investment Fund, Private Enterprise Foundation, Ghana Shippers Council and the Ghana Free Zones Board.

These supports, notwithstanding, firms within the non-traditional exports sector still face constraints which significantly contribute to some amount of inefficiencies exhibited by these firms. Baah-Nuakoh and Baah-Nuakoh (2003) have noted that a number of studies conducted on the industrial sector of Ghana have found important constraints particularly with regard to operation and efforts to expand. Some of these constraints include credit accessibility, sustainable demand for output, regulatory environment, taxes, infrastructure, high utility prices, imports, and skilled labour. Other relevant constraints which are relatively less discussed include management, skills and technology (Melford 1986). The study by Melford which was aimed at investigating the constraints facing manufacturing firms after the liberalization policy of the Economic Reform Programme (ERP) concluded that some financial problems are yet to be addressed.

Notwithstanding these constraints, Ghana has some comparative advantages over a number of developing countries within the West African sub-region and even across the African continent. These include a stable political environment, and a geographical location which facilitates easy access to significant regional markets like Nigeria and Cote d'Ivoire, and developed markets in Europe. Other factors include immense underutilized agricultural resources such as arable land, sunshine and water. The rest of the comparative advantages are adequate sea port, relatively cheap labour force, and a competitive exchange rate, which has kept, for most part of the previous two decades, local costs in line with those of other countries (World Bank 2001). Yet it must be quickly noted that although the doctrine of comparative advantage has been used in explaining efficiency, there is the need for firms to think beyond the existence of these advantages. This is evident in Rodrik (2004, p7) where it is remarked that "whatever it is that serves as the driving force of economic development, it cannot be the forces of comparative advantage as conventionally understood."

The conduct of strategic industrial and trade policies in this regard is therefore imperative in Ghana if the Non-Traditional Exports (NTE) sector possibly will become the real engine of growth. These policies will be intended to address constraints facing this sector and the larger industrial sector found in many studies. It is against this background that the government has, over the past two or more decades, designed and implemented various policies directed at the NTE sector with the motive of significantly enhancing its competitiveness to enable it generate more foreign exchange, employment and revenue. This will therefore reduce the economy's heavy reliance on the traditional sector.

The Ghanaian government's three-year Export Growth Strategy (2005-2007) is a more recent of these strategic policies. It outlined among other things key strategies to address export growth challenges and particularly move the NTE revenue from US$705million in 2004 to US$1250 in 2007. In this regard, the 2008 Budget document stated that an amount of GH¢16.5 million was disbursed to 50 NTE companies operating in various sectors of the economy in 2007. This was under the activities of the Export Development and Investment Fund which is geared towards increasing foreign exchange through enhanced exports of non-traditional products. These policies were largely deemed to have been efficient and targets achieved when the NTE sector recorded US$1,200 million at the end of 2007.

1.2 Statement of Problem

The significance of the non-traditional exports sector is well established in the literature as it holds the key to meaningful diversification of, and increase in, the export sector of Ghana's economy. Besides, Ghana, together with other West African countries, is negotiating an economic partnership agreement with the European Union (EU), the largest economic bloc in the world. This agreement, when signed, is expected to replace the existing non-reciprocal provisions in the Cotonou Agreement which expired on 31st December, 2007. The non-reciprocal provisions imply that Ghana has access to European markets without having to reciprocate by opening her own markets to EU products. In the mean time, Ghana, on Thursday December 13, 2007, signed an interim agreement on this matter, which is also called *stepping stone agreement*, with the EU, which has replaced the expired provisions in the Cotonou Agreement pending further negotiation.

The official ECOWAS position on this matter is that the partnership agreement takes effect by 1st January 2011, instead of the elapsed January 2008 (Government of Ghana 2007). And the expectation is that an agreement of a sort which further opens up markets of the ECOWAS and the EU, based on reciprocity will finally come to stay. The issue of concern is the level of efficiency of the Ghanaian export sector for this challenging opportunity. The non-traditional exports sector is particularly important because it is widely believed that it stands to benefit more should this agreement be signed. But these expected benefits could be achieved if the sector currently exhibits some appreciable level of efficiency. The problem therefore is the lack of information regarding the level of efficiency, and related matters, of firms in this sector that are particularly necessary for taking decisions and policy positions. More importantly, there is the need to examine the factors that influence the efficiency (or inefficiency for that matter) in this sector.

1.3 Purpose of the Study

The main purpose of this study is to estimate the level of efficiency that currently characterizes non-traditional exports sector firms. The specific objectives of the study are to:

i. Find out the characteristics of firms in the non-traditional exports sector.

ii. Determine the appropriate production function used in the non-traditional exports sector.

iii. Estimate the level of technical efficiency of the firms in the non-traditional exports sector.

iv. Examine whether firm-level characteristics of firms have influence on the technical efficiency level of non-traditional exports sector firms

v. Make appropriate policy recommendations based on the empirical results.

1.4 Study Hypotheses

In order to arrive at a meaningful result from this study, the following hypotheses will be tested:

i. $H_o = 0$: Each non-traditional exports sector firm is operating on a technically efficient production function.

ii. $H_o = 0$: The firm-specific- characteristics (nationality of firm and firm's year of establishment) have no effect on technical efficiency.

iii. $H_o = 0$: The characteristics of Primary Decision Makers (age, gender, and highest level of education attained) have no effect on technical efficiency

1.5 Motivation of the Study

The main motivation of the study stems from the relevance of the non-traditional exports sector to Ghana's quest to achieve middle-income status by 2015. This is also supported by the few studies that have actually been undertaken to estimate technical efficiency of NTE firms in Ghana. As Ghana, together with the sub-regional grouping ECOWAS, prepares to sign on to a full Economic Partnership Agreements with the EU, it is imperative that export sector firms, particularly those in the NTE sector, exhibit some appreciable level of efficiency. A number of similar studies have, however, been carried out to analyze Ghana's export performance (Bigsten et al., 2000, Baah Nuakoh, A 2003, and World Bank 2001). Much of the research work in the NTE sector has rather been of the qualitative type with a

few quantitative studies. Although the subject of technical and allocative efficiency is important, few studies have focused on these areas and particularly the NTE sector.

1.6 Significance of the Study

With the traditional export sector having been widely observed to have reached its turning point, further growth of the export sector and the Ghanaian economy at large would be expected to depend on the NTE sector. Consequently, the Government of Ghana, in its recent medium term development plan GPRS II, intends to diversify and expand the country's export sector. In order to achieve this aim, it is essential to estimate the current efficiency and productivity levels of firms in the export sector in general but particularly those of the non-traditional sector.

Diversification of and expansion in exports are key to economic growth of a developing country like Ghana for a couple of reasons. First, exports growth can increase employment and income, especially when they are labour-intensive. Second, exports can also earn scarce foreign exchange to finance the importation of capital and intermediate goods for changing the structure of the economy. Finally, diversification can reduce vulnerability to external price shocks that result from persistent reliance on few primary products. (World Bank 2001)

This study therefore attempts to provide empirical evidence of the level of productivity and efficiency that characterizes the non-traditional exports sector. The study, upon completion, would possibly serve as a reference document for a host of institutions such as Ministry of Trade and Industry, Ghana Export Promotion Council, Federation of Association of

Ghanaian Exporters, Association of Ghanaian Industries, and the donor community for the designation and implementation of strategic policies in the export sector. Finally, the study will form a baseline for further research activities in the export sector, which could aim at strategizing in order to break the dominance of the traditional exports sector.

1.7 Scope of the Study

The main focus of this study is the non-traditional exports sector. The study aims at estimating firm-level efficiency within the sector. There currently exist a number of classifications in the NTE sector. These are mainly product based or association based. New products are identified every now and then, and subsequently new associations are formed. The study focused on ten key products and consulted relevant associations to select firms to be surveyed for this study. The study used 60 firms from the NTE sector. This was mainly due to financial and time constraints.

1.8 Limitations of the Study

The whole study was expected to be completed and a report made ready in a maximum of twelve (12) months. This put some restriction on the design and focus of the study. Nonetheless all efforts were put in place to ensure that the academic reliability of the study was not compromised.

Data collection was characterized with severe problems as firms deemed some of the data they provided as confidential and sensitive. It therefore took more time than initially anticipated to collect enough data for the analysis.

It must also be noted that the non-traditional exports sector is a fast growing one and an attempt to study such a sector poses some inherent challenges. The number of products has increased substantially from 99 commodities in 1986, to 185 in 1993, and to 262 in 1999 (World Bank 2001). By the end of 2008, the total number of products classified as non-traditional export commodities had shot up to 383 (Ghana News Agency 2008). The increase in number of products has been coupled with increase in number of firms spread across the country.

1.9 Organization of the Study

This study is organized into six main chapters. The second chapter contains a detailed discussion on some developments in the exports sector in Ghana, with special reference to export performance, and domestic and donor community efforts to diversify and deepen export sector and enhance export competitiveness of the country.

Chapter three reviews the theory of stochastic frontier models and recent developments in stochastic models. In addition, related studies and empirical studies are reviewed. Other approaches to the technical efficiency are briefly discussed. Chapter four presents the model specification and detailed discussion of the variables, the study area and data sets to be utilized in the study. Chapter five discusses the results of the study. Finally, the summary, conclusions, recommendations, and suggestions for further research are discussed in Chapter six.

CHAPTER TWO

DEVELOPMENTS IN THE EXPORTS SECTOR OF GHANA

2.1 Introduction

The Ghanaian economy has made significant strides in developing its non-traditional exports since the early 1990s. At US$1,200 million at the end of 2007, non-traditional exports have increased tremendously from around US$125 million in 1993. In spite of this rapid growth, non-traditional exports contribute just about 10 per cent of Gross Domestic Product (GDP). Over the past two decades, the NTE sector has persistently contributed between 20 and 25 per cent of Ghana's total export earnings, suggesting that the traditional exports still dominate.

Strong export growth observed in Ghana since 1983 has been a major contributor to the economy's steady real GDP growth, averaging a little over 5 per cent annually after the economic reform programmes in 1983. This trend represents an important departure from a very weak export growth that characterized the economy between 1960 and 1983. The former trend is partly explained by the Economic Recovery Programme, facilitated by the World Bank that the country underwent, particularly exchange rate reforms. The pre-reform era trend can be explained by political instability coupled with perceived corruption and exchange rates misalignment.

The non-traditional exports sector's earnings for decades have hovered around 25 per cent of total exports earnings. This therefore indicates that more efforts will be required to ensure

that the NTE sector becomes one of the key engines of growth in the country. Such efforts, necessary to boost the non-traditional exports, could in turn trigger the desired growth for moving the Ghanaian economy into a middle-income earner status.

2.2 Overview of Exports Performance

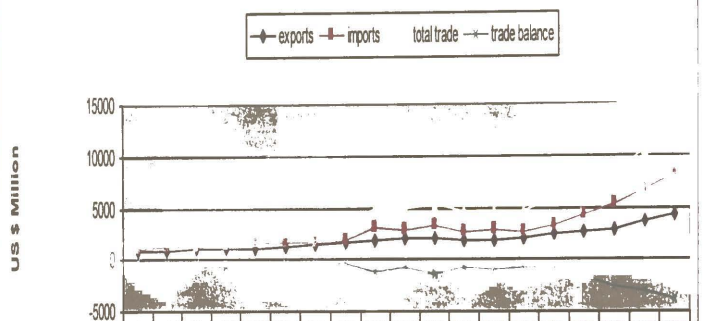
Over the 1960 to 2007 period, the value of Ghana's total exports increased from US$3,429 million to US$4,200 million (International Financial Statistics). The annual growth rate over the period thus averaged 18.6 per cent. Owing to structural problems and policies, Ghana's exports have been dominated by agricultural commodities, notably cocoa and timber. The three most dominant primary products namely gold, cocoa, and timber, constitute traditional export commodities of the country.

Resulting from the economic recovery programme launched in 1983, Ghana has enjoyed steady growth that has allowed the economy to move away from the back and forth movement in growth observed in the pre-reform era. As the economy moved on to a steady growth pattern, the country's exports have been, to a larger extent, rising in an incremental fashion. But it is worth noting, immediately, that the reforms also had some worrying impacts on employment, income, and resource endowed communities.

Fairly strong export growth has been a significant contributor to the country's steady real GDP growth that has averaged over five per cent annually over the last three decades. Nonetheless the surge in imports over the past five years is of much worry to the economy. This is partly explained by significant increases recorded by food and fuel prices between

2006 and 2008. The figure below shows the trend in merchandise trade from 1989 to 2007. The series include merchandise exports, merchandise imports, total trade, and merchandise trade balance.

Figure 2.1: Trends in Merchandise Trade



	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
exports	808.8	896.8	997.7	986.3	1064	1238	1431	1570	1809	2091	2006	1936	1827	2015	2562	2705	2802	3727	4195
imports	1012	1205	1319	1457	1728	1580	1688	1937	3041	2897	3280	2767	2831	2707	3233	4297	5347	6754	8074
total trade	1821	2102	2317	2443	2792	2818	3119	3507	4850	4988	5286	4703	4658	4722	5795	7002	8149	10481	12269
trade balance	-203	-308	-321	-471	-664	-342	-257	-367	-1232	-806	-1274	-831	-1004	-692	-671	-1592	-2545	-3027	-3879

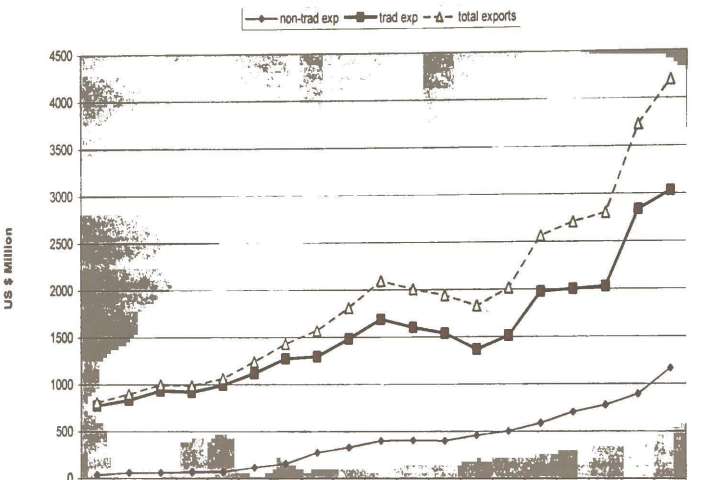
Year

Source: Compiled from Bank of Ghana Annual Reports and unpublished documents from Ghana Export Promotion Council

2.3 Trends in Traditional and Non-traditional Exports Sectors

In the aftermath of the Economic Recovery and Structural Adjustment Programmes by the Breton Woods institutions, especially from 1993, exports have, broadly speaking, increased though less consistently. Total value of exports recorded considerable falls between 1998 and 2001, mainly due to fall in prices of agricultural produce and somewhat unfavourable weather conditions experienced over the period. The Non-traditional exports recorded a steady growth over the period, mainly from 1993 through 2007, rebounding to significant yearly positive growth in the sector since 2000. From as low as US$ 37.2 million in 1989, NTE recorded total earnings of US$ 1164.5 million at the end of 2007. The NTE sector's contribution to total export earnings has therefore grown consistently from 4.6 per cent in 1989 to 20.7 per cent in 2000 and further to 27.8 per cent in 2007. The figure below shows the trend in the traditional and the non-traditional export earnings from 1989 to 2007, as well as the NTE sector contributions to total exports earnings.

Figure 2.2: Trends in Traditional and Non-Traditional Exports



	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
non-trad exp	37.2	62.9	62.6	68.4	71.7	119.3	159.7	276.2	329.1	401.7	404.4	400.7	459.6	504.3	588.9	705.4	777.6	892.9	1165
trad exp	771	833.9	935.1	917.9	991.9	1118	1272	1294	1480	1689	1601	1536	1367	1511	1974	1999	2025	2834	3030
total exports	808.2	896.8	997.7	986.3	1064	1238	1431	1570	1809	2091	2006	1936	1827	2015	2562	2705	2802	3727	4195

Years

Source: Compiled from Bank of Ghana Annual Reports and unpublished documents from the Ghana Export Promotion Council

Table 2.1: Trend in Export Components with NTE Contribution

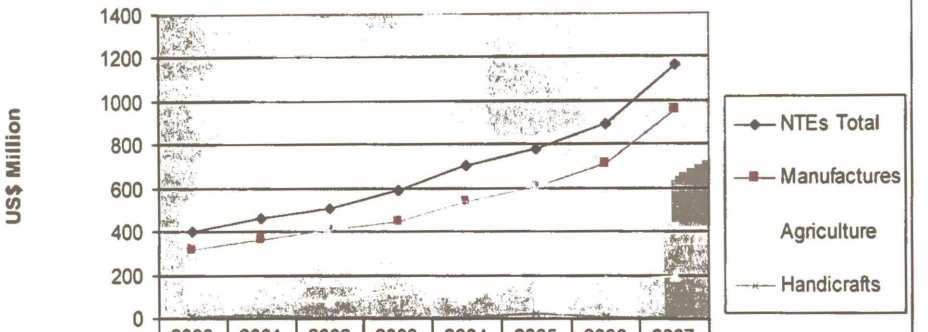
Years	Non-traditional Exports (US$ million)	Traditional Exports (US$ millions)	total exports (US$ millions)	% NTE Contribution
1989	37.2	771	808.2	4.602821
1990	62.9	833.9	896.8	7.013827
1991	62.6	935.1	997.7	6.274431
1992	68.4	917.9	986.3	6.93501
1993	71.7	991.9	1063.6	6.741256
1994	119.3	1118.4	1237.7	9.638846
1995	159.7	1271.5	1431.2	11.15847
1996	276.2	1293.9	1570.1	17.59124
1997	329.1	1480.2	1809.3	18.18935
1998	401.7	1689.1	2090.8	19.21274
1999	404.4	1601.1	2005.5	20.16455
2000	400.7	1535.6	1936.3	20.69411
2001	459.6	1367.4	1827	25.15599
2002	504.3	1510.9	2015.2	25.02481
2003	588.9	1973.5	2562.4	22.98236
2004	705.4	1999.1	2704.5	26.08246
2005	777.6	2024.6	2802.2	27.74963
2006	892.9	2833.8	3726.7	23.95954
2007	1164.5	3030.2	4194.7	27.76122

Source: Compiled from Bank of Ghana Annual Reports and unpublished documents from the Ghana Export Promotion Council.

The non-traditional exports are categorized into three different products. They are agricultural products, processed and semi-processed products, and handicrafts. The agricultural products are made up of horticultural products such as pineapple, assorted vegetables and fruits, yam/cocoyam, and other vegetables and fruits; fish and sea foods such as tuna fish, frozen fish, dried/smoked fish, and other fish and sea foods; kola nuts and

others. The processed and semi-processed products include aluminium products, prepared foods and beverages, common salt, non-ferrous metal scrap, natural rubber sheet, and other processed and semi-processed products. Handicrafts are made up of assorted handicraft, basketware and others (Bank of Ghana Annual Report 1998). The figure below depicts the trend in the major components of NTE from 2000 to 2007. The manufactures sub-sector has clearly been very dominant in the NTE, reasonably suggesting its potential for overtaking some traditional exports.

Figure 2.3: Trends in Components of Non-Traditional Exports from 2000 to 2007

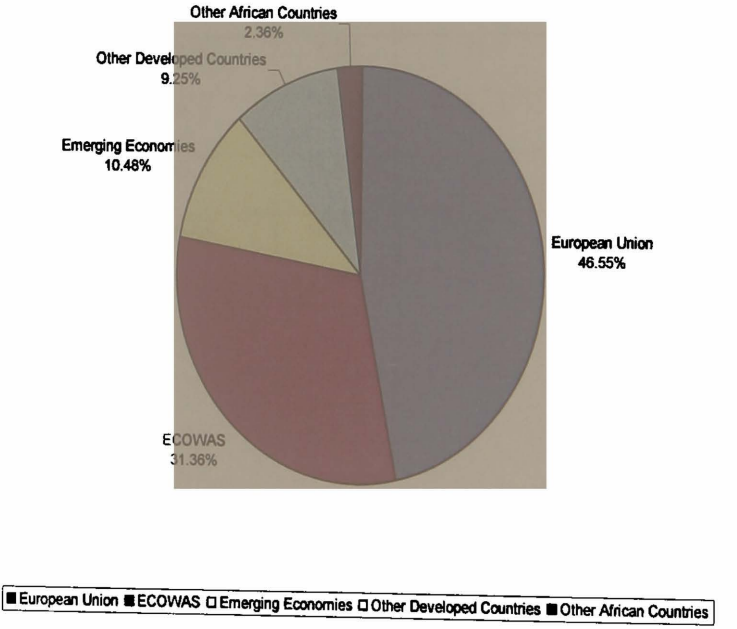


	2000	2001	2002	2003	2004	2005	2006	2007
NTEs Total	400.66	459.6	504.25	588.89	705.43	777.58	892.88	1164.5
Manufactures	321.14	362.73	407.21	446.58	540.38	604.84	710.89	963.48
Agriculture	74.54	81.98	85.73	138.14	159.85	151.86	177.5	197.24
Handicrafts	4.98	14.89	11.31	4.17	5.2	20.88	4.49	3.79

Source: Unpublished documents from the Ghana Export Promotion Council

The performance of the NTE sector by market destinations over the past decade shows that the European Union (EU) and the Economic Community of West African States (ECOWAS) together absorb more than three-quarters of the total output. In the year 2007, the EU and ECOWAS were the destinations for 46.55 per cent and 31.36 per cent respectively of non-traditional exports from Ghana (Ghana Export Promotion Council, 2008). The pie-chart below throws more light on NTE markets worldwide. Two tables have also been included below indicating leading market destinations in the world and West Africa as well as how the non-traditional exports performed in 2006 and 2007.

Figure 2.4: Non-Traditional Export Markets



Source: Ghana Export Promotion Council

Table 2.2: Ten Leading Non-Traditional Exports Market Destinations in the World

Country	2006 (US $ Million)	% Cont. to NTE	2007 (US $ Million)	% Cont. to NTE	% Growth Rate
U K	108.2	12.12	133	11.42	22.92
France	82.1	9.19	131.6	11.30	60.29
Nigeria	67.6	7.57	113.6	9.75	67.93
Netherlands	50.2	5.62	83.8	7.20	66.93
Burkina Faso	77.1	8.63	70.8	6.08	-8.17
U S A	55	6.16	62.2	5.34	13.09
Togo	24.4	2.73	60.5	5.19	147.79
Cote d'Ivoire	31.8	3.56	51.7	4.44	62.54
Spain	43.2	4.84	51.2	4.40	18.52
Germany	45.7	5.12	43.2	3.71	-5.47
Total	585.1	65.53	801.3	68.81	36.95

Source: Ghana Export Promotion Council

Table 2.3: Ten Leading Non-Traditional Exports Market Destinations in West Africa

Country	2006 (US$ Million)	% Cont. to NTE	2007 (US$ Million)	% Cont. to NTE	% Growth Rate
Nigeria	67.6	7.57	113.6	9.75	67.93
Burkina Faso	77.1	8.63	70.8	6.08	-8.13
Togo	24.4	2.73	60.5	5.19	147.79
Cote d'Ivoire	31.8	3.56	51.7	4.44	62.54
Benin	8.0	0.90	24.9	2.14	209.84
Niger	10.7	1.20	15.0	1.29	39.91
Senegal	6.8	0.76	9.6	0.83	42.40
Sierra Leone	1.7	0.19	5.5	0.47	223.76
Mali	8.3	0.93	5.3	0.45	-36.33
Guinea	1.9	0.21	3.0	0.25	56.23
Total	238.3	26.69	359.7	30.89	50.96

Source: Ghana Export Promotion Council

2.4 Domestic Efforts to Boost Exports

Domestic efforts being made to further diversify and deepen the exports sector of Ghana could be classified under two broad categories; governmental efforts and non-governmental efforts. Governmental efforts are made up of the establishment of agencies and institutions, and the execution of certain key projects by the Government of Ghana with the aim of enhancing the exports sector. The non-governmental efforts, on the other hand, include private sector institutions and activities that complement governmental efforts.

2.4.1 Governmental Efforts

There are quite a number of institutions and activities managed and being implemented concurrently by the Government of Ghana to enhance export competitiveness and to increase exports. This section identifies and discusses vital governmental institutions and activities.

The Ministry of Trade and Industry (MOTI) is the principal government agency with overall responsibility for the formulation, implementation, and monitoring of the country's internal and external trade, including bilateral and multilateral agreements. The ministry is also in charge of formulating the country's industrial polices. The ministry is also responsible for strengthening trade relations with other countries, taking cognizance of Ghana's membership of international organizations and agreements that the country has signed on to. MOTI's major aim is to raise exports generally, with special reference to the non-traditional exports sector, in order for the country to finance her development without undue reliance on external funds. This is evident from the establishment of Ghana Export and Promotion Council. Other ministries, such as the Ministry of Finance and Economic Planning and the Ministry of Foreign Affairs, also play roles in the government's coordinated effort to boost exports. Revenue collecting agencies as well as sea and air ports authorities do cooperate in MOTI's agenda.

The Ghana Export Promotion Council (GEPC) is an essential establishment by the government, through MOTI, to assist in the diversification and deepening process of the export sector of the country. Established as an agency within MOTI, the council was mandated to facilitate the development and promotion of non-traditional export commodities.

GEPC is responsible for the development of national export awareness, identification of products with export potential and locating markets for them. The council also provides exporters with the necessary assistance to enter markets, it organizes trade missions, train exporters to upgrade skills in export marketing and export management.

The Government of Ghana in collaboration with the International Development Association (IDA) initiated the Private Enterprise and Export Development (PEED) project. The PEED project which span the period 1993 and 1998 was aimed at promoting non-traditional exports by making export credits available to non-traditional exports sector firms through the banking system. Around the same period another relevant project implemented by the government with support from IDA was the Fund for Small and Medium Enterprises Development (FUSMED) which sought to ease access to credit by the private sector.

The Trade Sector Support Programme (TSSP) spanning 2005-2010 identifies challenges and makes specific recommendations that need to be considered in order to deliver the policy prescriptions of the Ghana Trade Policy and to consolidate the country's export-led growth strategy. The TSSP aims at contributing to an accelerated sustainable economic growth and increased incomes and employment for Ghanaians. It comprises of twenty-six separate projects clustered into ten thematic components (Ministry of Trade and Industry 2005). The thematic components are as follows; multilateral trade, import-export regime, trade facilitation, production capacity, and export trade support services. The remaining components are standards, domestic trade and distribution, competition and government procurement, consumer protection, and intellectual property rights.

The Ghana Trade and Investment Gateway Programme (GHATIG) is one of the novel initiatives by the government and supported by the World Bank and the United States of America International Development (USAID). GHATIG, also referred to as the Gateway Project for short, was conceived in 1998 but reviewed and amended in 2005. The programme has the following objectives:

- Attract a critical mass of export oriented investors to Ghana;
- Accelerate export-led growth;
- Facilitate trade; and
- Position Ghana as the gateway (and trade base) to the West African sub-region.

The Gateway Project has three major components. They are Free Zones Development (Tema), Trade Facilitation, and Investment Promotion.

The Gateway project, when completed, is expected to remove significant hurdles at various entry points into the country. The project would also create much friendlier business environment, particularly in support of an export-led growth strategy. This would be achieved through the creation of export processing zones with incentives such as easy access to land and non-payment of some taxes.

The promulgation of the Export Development and Investment Fund Act 582 in October 2000 with the consequent establishment of the fund is another major step made by the government to further boost exports. The main purpose fund (EDIF) is to make financial resources available for the development and promotion of Ghana's export trade. EDIF specifically provides and guarantees credit on behalf of exporting firms, and undertakes export insurance,

re-financing and general export promotion and development (Kwakye-Mintah K. 2007). Sources of funding for EDIF include 10 per cent of proceeds realized from the divestiture of state-owned enterprises, grants from government, and loans and other credit facilities that the board may obtain with government guarantee (Kwakye-Mintah K. 2007).

2.4.2 Non-Governmental Efforts

These are mainly private sector institutions, usually association, that provide general business and trade support services to member firms. There are currently numerous private sector institutions in the country. Key organizations to be discussed here include the Association of Ghana Industries (AGI), Federation of Associations of Ghanaian Exporters (FAGE), Private Enterprise Foundation (PEF), and the Ghana National Chamber of Commerce (GNCC). Other relevant institutions worth noting include bilateral chambers of commerce, such as Ghana-Nigeria Chamber of Commerce, Ghana-German Economic Association, Ghana-USA Chamber of Commerce, and Ghana-British Chamber of Commerce. Other organizations include Product Associations (more than 15 in number) that the Ghana Export Promotion Council relates with.

The AGI was established in 1958 by a group of indigenous manufacturers with the main aim of contributing to the growth and development of industries in the country. As a not for profit organization with a membership of over 1,500 it also aims at assisting in the creation of conducive business climate, which will allow Ghanaian firms to be competitive locally and internationally. The group carries out relevant research activities and facilitates various forms of training for the benefit of member firms. AGI is noted for making various inputs into the

Annual budget statement of the government as well as the government's medium term strategic documents. It has been a very influential mouth-piece of the Ghanaian business community.

The Federation of Associations of Ghanaian Exporters (FAGE) is a private organization of Ghanaian exporters and exporter associations. It is comprised of more than 2,500 exporting firms producing assorted traditional and non-traditional export commodities. The association aims at providing technical and information services to assist Ghanaian firms and their foreign partners in their operations.

The Private Enterprise Foundation (PEF) was instituted on the initiative of four major business association namely Association of Ghanaian Industries (AGI), Ghana National Chamber of Commerce (GNCC), Federation of Associations of Ghanaian Exporters (FAGE), and the Ghana Employers Association (GEA). With support from government of Ghana, USAID, and DANIDA, PEF undertakes research and influences policies and regulations towards the creation of an enabling environment for a private-sector led economic growth. The Foundation monitors best practices, identifies strategic factors responsible for enterprise competitiveness, and circulates such findings to member associations and constituent firms. PEF makes regular contributions to the government's annual budget and medium term policy documents.

The GNCC was established in 1961 under an Act of Parliament (Executive Instrument No. 196) following the merger of the then four existing Chambers of Commerce. As an

independent institution, the GNCC has promoted, and continues to promote, the commercial and industrial interest in Ghana, being a leading business support service provider in the country. It facilitates training activities for the business community and provides a variety of information, particularly export market information and documentation.

2.5 Donor Community Efforts

As international trade increases in its relevance to economic growth and development, donor community efforts in Ghana to boost trade, especially exports, have improved. Though more focused on combating poverty in its varied forms, the international community in Ghana concurrently runs several projects generally aimed at private sector developments but specifically addresses some challenges faced by Ghana's export industry. Key relevant projects to be discussed here include the Trade and Investment Reform Programme (TIRP), Millennium Challenge Account (MCA), Ghana Trade Policy Project, Private Sector Development Programme (sponsored by DANIDA), and Joint Integrated Technical Assistance Programme (JITAP), among others.

The TIRP is a five year programme started in July 1998 by the United States of America with the aim of enhancing Ghana's potential to earn sufficient foreign exchange and compete on the global market (USAID FY 1998 Congressional Presentation on Ghana). The TIRP, over the programme period, supported policy reforms, technical assistance, and training to improve the investment environment and technical capacity of local firms. Overall, the programme supported efforts to increase USA trade with and investment in Ghana. The programme, worth US$ 74 million, was planned and implemented upon the success of its

predecessor, the Trade and Investment Programme (TIP). The TIRP emphasized more on non-traditional exports, a considerable portion of which were agricultural based products.

The MCA Ghana programme is a five-year agreement signed in 2006 between the governments of Ghana and the United States of America in which the latter commits herself to grant the former an amount to the tune of US$ 547 million. The Ghana programme aims to reduce poverty by raising farmer incomes through private sector-led, agribusiness. The programme intends to increase the production and productivity of high-value cash and food staple crops and particularly to enhance the competitiveness of the country's agricultural products in regional and international markets. This is separate from the USA's commitment towards supporting the implementation of government of Ghana's own Private Sector Development Strategy.

The Ghana Trade Policy Project was a two-year technical co-operation activity which ended in 2004 and was funded by the British government through the Department for International Development (DFID). The project was a response to a formal request from the government of Ghana for support in trade policy formulation and preparations for multilateral, regional, and bilateral trade negotiations. The goal of the project was to enable Ghana secure her objectives in trade negotiations and thereby increase the country's participation in international trade. Other initiatives supported by the DFID included the Private Sector Development Strategy and the Trade Sector Support Programme.

The DANIDA Private Sector Development Programme (PSD) was started in 1993 and provides support to cooperation between Danish companies and companies in other developing countries including Ghana (Royal Danish Ministry of Foreign Affairs). The PSD aims at facilitating contacts between firms in the two countries, mainly in the form of technical assistance, training, and ultimately the provision of grants and loans some of which do support export promotion activities. DANIDA is among 12 development partners who have signed a memorandum of understanding with the government in support of Ghana's Private Sector Development Strategy approved in 2004.

Ghana has since 1999, participated in the JITAP, an initiative jointly sponsored by the World Trade Organization (WTO), International Trade Centre (ITC), and the United Nations Conference on Trade and Development (UNCTAD). The JITAP provided assistance in the follow-up and implementation of the Uruguay Round Agreement. Understandably, JITAP is a special donor project that brings together relevant ministries and government agencies to discuss trade policy. In Ghana the project set up a resource centre for firms registered with the GEPC and funded workshops on public-private sector dialogue.

2.6 Conclusion

From the discussion above, it can be deduced that the export sector has steadily grown after the economic reform programmes. Efforts to diversify the export base have achieved some results as the non-traditional exports sector's annual contribution to the total export earnings peaked at roughly 28 per cent by the end of 2007. Domestic and donor community efforts towards developing the private sector on the whole and the NTE sector in particular have

been intensive over the past decade. However the NTE is yet to break the dominance of the traditional exports sector.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

The chapter reviews relevant literature in the field of efficiency estimation. The discussion is broadly divided into three; review of theoretical literature, developments in the efficiency estimation and empirical literature. The discussion on theoretical literature focuses on production theory, technical efficiency, economic efficiency, productivity and other recent developments. Developments in the measurement of efficiency are discussed afterwards, followed by a discussion of empirical literature on efficiency estimation.

3.2 Theory of Production

The theory of production provides the theoretical and the analytical framework for most empirical research on efficiency and productivity estimation. It is as such the main theoretical framework within which this thesis is situated. Production, in economics, regards the combination of various inputs, using a given technology, in the creation of a specific commodity or service. The relevance of production is argued to be implied in the central problem of economics, scarcity. Traditional production theory classifies production inputs into four namely entrepreneur, labour, land, and capital. These inputs, in modern theories of production, are classified differently. For example capital is further divided into physical capital and human capital.

For an individual firm, a relation, often viewed as technical in nature, which connects its factor inputs and outputs is known as a production function (Koutsoyiannis, 1979). All technically efficient production processes are understandably included in the function. For a given number of production processes in the production of a given unit of output, the one which uses less of at least one input and no more of the other inputs as compared with the other processes is deemed as a technically efficient production process. Due to the scarce nature of these inputs, a major objective of production, besides an attempt at satisfying the insatiable human wants, is to achieve economic efficiency in production processes. Economic efficiency, which is different from technical efficiency, regards the use of minimum necessary resources to obtain a socially optimal amount of goods and services (McConnell and Brue, 2002).

All technically efficient processes involved in the production of a given unit of output are included in what is technically known as an *isoquant*. An isoquant is thus a curve that shows all possible (minimum) combinations of factors of production that can be used in the production of a given level of output (Ofori-Atta, 1998). The production function describes a whole array of isoquants, each of which shows a different output level, and not only a single isoquant (Koutsoyiannis, 1979). Two groups of laws of production have been established in the theory of production that describes technically possible ways of raising output levels. They are laws of returns to scale (long-run analysis) and laws of variable proportions (short-run analysis). Law of returns to scale (increasing, constant, and decreasing) refers to changes in output as a result of varying all factors of production whereas law of variable proportions

(increasing, constant, and decreasing) concerns variations in output that results from changes in a particular input, holding other inputs constant.

Besides the above laws, output does expand in response to technological advancement "over a theoretical time period called the *very long run*, which can be as short as few months or as long as many years" (McConnell and Brue, 2002). Technological advancement, which sometimes changes the shape and/or produces a shift in an isoquant and hence a production function, usually results as knowledge of new and more efficient methods of production becomes available to the firm. In the aftermath of the World War II, issues regarding technological advancement, such as invention, innovation, and diffusion have taken a centre stage in production theory. McConnell and Brue have noted that the basis of technological advancement is invention which they define as "the discovery of a product or process through the use of imagination, ingenious thinking, and experimentation and the first proof that it will work." (McConnell and Brue, 2002, p 511)

Innovation, which is of two types (product innovation and process innovation), draws directly on invention. It is defined as "the first successful commercial introduction of a new product, the first use of a new method, or the creation of a new form of business enterprise" (McConnell and Brue, 2002, p 511). Innovation has been noted as an important factor in competition as it permits a firm to outperform its competitors. The third element of technological advancement is diffusion which regards the spread of innovation through imitation or copying. Technological advancement was for decades regarded by most economists as a random external factor to which the economy adjusted (McConnell and

Brue, 2002). Contemporary economists, however, hold a contrary view and regard technological advancement as internal to the economic system. They are of the view that invention, innovation, and diffusion do occur in an economy mainly in response to economic incentives.

Technological advancement makes well noted and important contributions to economic efficiency. Economic efficiency entails both productive efficiency and allocative efficiency. Productive efficiency regards the production of a given level of output at the lowest achievable unit cost whiles allocative efficiency requires that inputs be apportioned among various firms in order to ensure that a composition of goods and services most desirable by consumers is achieved. For a given firm, productive efficiency is achieved when the unit price of a commodity equals the minimum average total cost incurred in its production whiles allocative efficiency results if unit price of a commodity equals marginal cost of production. A firm is said to have achieved economic efficiency if it is found operating on its *production possibility frontier* (PPF). A PPF is a curve that shows the different combinations of commodities which use up all available resources of a firm at a given level of technology.

One of the most cited attempts made to empirically measure productive efficiency is the work by Farrell (1957). Using programming techniques, Farrell showed how to decompose cost efficiency into two components; technical and allocative components. Production frontiers have been widely used to assess the efficiency of firms, following Farrell's work. Two techniques that have been used for the decomposition of productive efficiency are parametric and non-parametric methods. They are predicated on some stochastic and non-

stochastic assumptions. Both techniques (parametric and non-parametric) are used in the assessment of productive efficiency with both cross section and panel data.

3.3 Technical Efficiency Estimation

The level of technical efficiency (or inefficiency) exhibited by a firm in its production processes is characterized by the relationship between observed production and potential or ideal production (Greene, 1993). The measurement of firm-level technical efficiency is therefore based on the movement of observed output levels away from the efficient production frontier. Consequently, whenever a firm's actual production lies on the production frontier, such a firm is said to be technically efficient. And on the other hand, if the firm's level of output lies below the production frontier then it is technically inefficient. Firm-level efficiency is thus defined as the ratio of actual to potential output levels.

The definition of technical efficiency put forward by Farrell (1957) has underpinned the development of various techniques used in estimating relative technical efficiency of firms. In all these techniques the extraction from extreme observations from a body of data in order to determine the best practice production frontier has been a common feature (Lewin and Lovell, 1990). A relative measure of technical efficiency at the firm-level can thus be derived from this. This similarity, notwithstanding, two clearly distinct approaches namely parametric and non-parametric methods have been used in empirical research.

The parametric method, mainly the stochastic frontier approach, includes a measure of random error and involves the estimation of a stochastic production function, where the level

of output depends on a set of inputs, inefficiency and random error. Some of the functional forms generally used by parametric methods of estimating efficiency include the Cobb-Douglas and the Transcendental Logarithmic (Translog) functions. A widely discussed disadvantage of the parametric approach, however, is the imposition of an explicit functional form and some distributional assumptions on the data.

Another parametric method which has been used in empirical studies, though to a lesser degree, is the deterministic technique associated with Aigner and Chu (1968) and Gabrielson (1975). This deterministic method does not allow for stochastic shocks to production and it has been criticized for attributing deviations from the frontier output entirely to inefficiency. This criticism has induced a number of econometricians to abandon deterministic frontiers as a helpful model for efficiency measurement in favour of stochastic frontier models. In this case, each firm faces a production frontier which is randomly placed by the whole collection of stochastic shocks beyond the control of the firm (Sena, 1999).

In contrast, the non-parametric method, mainly a linear programming technique of data envelopment analysis (DEA), does not include any random error, and neither imposes an explicit functional form nor any distributional assumptions on the data. It measures efficiency based on observed input-output ratios using linear programming technique (Sena, 1999). The DEA technique, developed by Aigner and Chu (1968) and Gabrielson (1975) is thus less vulnerable to errors of mis-specification. The efficiency estimates from non-parametric method is criticized to be biased, particularly when production processes are significantly influenced by stochastic factors.

3.4 Basic Stochastic Frontier Approach

The stochastic composed error frontier methodology was developed by Aigner, Lovell, and Schmidt (1977), and Meeusen and Van der Broech (1977) independently. The development followed efforts by Farrell (1957) to directly measure productive efficiency of firms. Farrell's approach has been described as deterministic nonparametric frontier (Forsund, Lovell, and Schmidt, 1980). Earlier work by Aigner and Chu (1968) which specified a parametric production function of certain inputs and suggested the estimation of the parameters using a mathematical programming method also inspired Aigner *et al.* (1977) in the development of the model. The approach by Farrell, on the other hand, attributes any deviation from the frontier to inefficiency and imposes no functional form on the data. The effort, which was pioneering, in this field had some restrictions; it does not accommodate stochastic shocks to production process.

Aigner, Lovell, and Schmidt (1977) on their part formulated a model with an error term which was further decomposed into two parts. The first part of the error term is independently and identically distributed and uncorrelated with the regressors. The second part, referred to as the inefficiency term, is independently (but not identically) distributed as non-negative truncations of the normal distribution. Others have suggested other distributions, such as gamma, for the second component the error term. The specification therefore allows for the second component of the decomposed error term to generate a measure of inefficiency, thus a ratio of actual to expected maximum output, for given inputs and technology.

Besides allowing for the measure of technical inefficiency, the stochastic frontier formulation acknowledges the fact that certain random shocks external to the firm, such as weather, political and macroeconomic stability, can affect levels of output. Kumbhakar and Lovell (2000) have also noted, as it is well established in theory, that variations in levels of output can result from poor incentives, mismanagement, inappropriate input combinations or imperfect competitive behavior. The basic formulation of the stochastic frontier model is the classical cross-sectional linear regression model. It has non-normal, asymmetric disturbances decomposed into two components (Aigner *et al.*, 1977; Schmidt and Lovell, 1979). It is specified as follows:

$$y_i = \beta' x_i + \varepsilon_i; \varepsilon_i = v_i - u_i; u_i \geq 0; v_i \square N(0, \sigma^2) \qquad (3.1)$$

where i = 1,2,3, ..., N;

y_i is the natural logarithm of observed output of firm *i*;

x_i is a vector of logarithm of inputs;

β is a vector of parameters that will be estimated;

ε_i is the compound disturbance to the frontier;

v_i is the stochastic noise, with the usual Gaussian properties and represents other random factors such as strike, weather, and luck (Coelli *et al.*, 1998); and

u_i, represents the technical inefficiency, which is assumed to be distributed independently of v_i and satisfies the constraint $u_i \geq 0$.

In a related development, stochastic cross-sectional cost functions have been formulated where $\varepsilon_i = v_i + u_i$, (Fried, Lovell and Schmidt, 1993). These results have subsequently been

extended to include stochastic panel data frontiers, where the inefficiency con either be time-invariant or time-variant.

The stochastic frontier approach to efficiency estimation distinguishes between t or actual output (y_i) and the unobserved efficient or frontier output (y_i^*). (observed) output is specified as follows;

$$y_i = \beta' x_i + v_i - u_i$$

While the unobserved frontier output is specified as

3.5 Developments in Stochastic Frontier Approach

The stochastic frontier approach, since it was first formulated, has gone through considerable modifications. These modifications have followed the pioneering but independent works of Aigner *et al.* (1977), Battese and Corra (1977), and Meeusen and van den Broeck (1977). The initial cross-sectional model was extended to analyze panel data by Pitt and Lee (1981). The paper was among the early empirical works which raised the issue of the explanation of the technical inefficiency component in the stochastic frontier model.

One of the remarkable developments in the stochastic frontier approach was offered by Jondrow *et al.* (1982). In previous applications of the model, individual firm efficiency measures could not be derived directly from the stochastic frontiers (Bravo-Ureta and Rieger, 1991). This inability was solved by Jondrow *et al.* (1982) and in addition they introduced an approach that purges the purely random error of the stochastic frontier model from the efficiency component. Jondrow *et al.* (1982) also developed two predictors for the firm-level effect for an individual firm based on two assumptions (1) parameters of the frontier production function were known and (2) cross-sectional data were available for sample firms.

Following the work by Jondrow *et al.* (1982), Schmidt and Sickles (1984) explored a number of methods of predicting individual firm effects. This was then extended to using panel data on sample firms. The properties of firm-level technical efficiencies considered earlier by Jondrow *et al.* (1982), together with two other possible predictors, were further investigated by Waldman (1984). In what appeared to be a concluding paper, Battese and Coelli (1988) provided a generalization of these predictors based on the availability of panel data, and on the assumption that a general distribution for firm effects applies for stochastic frontier

functions. Battese and Coelli (1988) used the stochastic frontier model where the inefficiency component is firm-specific but time invariant.

The original stochastic frontier model allowed for the computation of allocative, technical and, hence, of economic efficiency. However, this computation was restricted to a technology exhibiting constant returns to scale. Extension works by Kopp (1981), Kopp and Diewert (1982), Akridge (1989), Kumbhakar (1987), and Schmidt and Lovell (1979) have led to alternative formulations of parametric models which relax the linear homogeneity restriction while enabling the calculation of the various efficiency indexes (Bravo-Ureta and Rieger, 1991). The models developed by Akridge (1989), Kumbhakar (1987), and Schmidt and Lovell (1979) require the joint estimation of the production frontier together with the necessary or first-order conditions for profit maximization or cost minimization. Kopp generalized Farrell indexes of productive efficiency to non-homothetic production technologies, but maintained the cost interpretation of Farrell measures (Kopp, 1981)

Kopp and Diewert (1982) also developed a different decomposition technique from a deterministic to a stochastic model. This stochastic formulation yields technical, economic, and allocative efficiency measures that are devoid of distortions that usually stem from statistical noise which is inherent in deterministic models (Bravo-Ureta and Rieger, 1991). Kopp and Diewert's (1982) decomposition model also allows for an elaborate efficiency analysis which relies on the econometric estimation of a production frontier. This is very useful because the firm-level price data required for the estimation of dual (cost or profit) models are often unavailable or inadequate (Quiggin and Bui-Lan, 1984). Kopp and

Diewert's decomposition approach is based on a deterministic frontier and imposes a limiting assumption that any deviation from the frontier necessarily results from inefficiency. Consequently, the resulting inefficiency measures are biased (Schmidt, 1985).

Earlier applications using the stochastic frontier model, including Aigner, Lovell and Schmidt (1977) have largely used two sets of distributions for the decomposed error components of the model. They are the normal-half normal distribution and the normal-exponential distribution, for v_i and u_i, respectively, as per defined in earlier equations, say equation 3.1. However, Beckers and Hammond (1987), Stevenson (1980), and Greene (1990) introduced normal-gamma distribution for the decomposed error terms. The normal-gamma model, as argued by proponents, has the advantage of providing richer and more flexible parameterization of the inefficiency distribution in the stochastic frontier model than the original forms.

Econometric analyses using frontier models have proceeded in two steps. In the first step, stochastic frontier functions are estimated together with the firms' efficiency levels. In this step, exogenous variables that are known to affect technical efficiency are ignored. The second step then establishes a possible relationship that exists between technical efficiency and the exogenous factors. This is usually done by carrying out a regression with the measure of technical efficiency as the dependent variable and the exogenous factors as independent factors. It has been recognized that this two-step approach gives biased results since the model specified in the first stage is misspecified. Caudill and Ford (1993) provided evidence on this bias, particularly of the estimated technological parameters.

Just around the time that Caudill and Ford (1993) provided evidence on the *biasedness* of the two-step approach, attempts were being made by Kumbhakar, Ghosh and McGuckin (1991), Reifschneider and Stevenson (1991) and Huang and Liu (1994) to develop the one-step approach widely used today. In their works, they proposed the simultaneous estimation of the parameters of the stochastic frontier together with the inefficiency model, given appropriate distributional assumptions associated with the cross-sectional data on the sample firms. In the Battese and Coelli (1995) work a model for technical inefficiency effects in a stochastic frontier production function was proposed.

Battese and Coelli (1995) also proposed a stochastic frontier production function for panel data, in which the technical inefficiency effects were specified in terms of various explanatory variables, including time. In a related development, Huang and Lui (1994) specified a non-neutral stochastic frontier production function in which the technical inefficiency effects were specified in terms of various firm-specific variables and interaction among these variables and the input variables in frontier function. Earlier, Reifschneider and Stevenson (1991) proposed a stochastic frontier model in which the technical inefficiency effects were dependent on other variables.

Bera and Sharma (1999) in a follow-up to an issue raised in Jondrow *et al.* (1982) showed that in a standard stochastic frontier model, an attempt by firms to move towards the frontier has two important implications. The first implication which is widely discussed is the concurrent increment in the firms' technical efficiency. The other implication, less discussed,

is the reduction in the firms' production uncertainty as a result of moving closer to the production frontier. Bera and Sharma (1999) proposed a measure of production uncertainty using conditional variance of the inefficiency component of the error term of stochastic frontier. They constructed confidence intervals for firm specific inefficiency and made use of standard errors to perform hypothesis tests. Of particular interest are the facts that the introduction of production uncertainty is valid for different distribution assumptions for u_i and that when a firm reaches its most efficient level of operation, it also has the least production uncertainty (Bera and Sahrma, 1999).

Coelli *et al.* (1998) developed the stochastic, parametric equivalent of the decomposition of the deterministic, non-parametric Malmquist Total Factor Productivity (TFP) index used by Fare *et al.* (1992). The Malmquist TFP index is computed from efficiency change and technological change indices between two adjacent periods. These authors showed that the technical efficiency of firm i at time t is equivalent to the distance function at time t. The efficiency change component of the Malmquist TFP is thus the ratio of technical efficiencies between two adjacent periods. In the same vein they showed that the technological component of the Malmquist TFP can be directly computed from the estimated parameters of the stochastic production frontier.

In a similar spirit like that exhibited by Caudill and Ford (1993), Wang and Schmidt (2002) extended the investigations into the nature and the severity of bias involved in the two-step approach. Whereas the evidence provided by Caudill and Ford (1993) were mainly about the bias of estimated technological efficiency, Wang and Schmidt (2002) extended it by

considering the efficiency levels themselves and their relationship to the exogenous variables. Their evidence, which was based on a Monte Carlo simulation exercise conducted to investigate the performance of one-step and two-step estimators, pointed to the existence of serious bias at all stages in the two-step procedure. Wang and Schmidt (2002) therefore concluded that the solution to the bias problem is a one-step procedure of estimation which is based on correctly specified stochastic frontier model. They also provided new theoretical insights into the bias problem.

Greene (2003) enhanced earlier efforts replace normal-half normal and normal-exponential distributions of the error components with normal-gamma distribution. He essentially proposed a normal-gamma model which is based on the method of maximum simulated likelihood estimation. Greene (2003) noted that attempts by researchers to utilize the normal-gamma distribution have met with very limited success. This was attributed to the significant degree of complexity that must be involved using the log likelihood approach. Further, the earlier attempt (Greene, 1990) utilized a direct but crude maximization procedure to estimate the inefficiency parameter, which was viewed not to be sufficiently accurate to produce satisfactory estimates.

Beside specification and estimation discussions concerning the stochastic frontier model, the problem of heterogeneity (heteroscedasticity) has also attracted a lot of attention. The heterogeneity problem was investigated by Caudill *et al.* (1995), who also observed that residuals, upon which inefficiency measures are derived, are sensitive to specification errors. They argued that this problem is more serious in frontier models, since in frontier models, an

increase in dispersion changes the frontier. This issue was taken up again by Hadri (1999), who proposed that heteroscedasticity must be introduced not only in the one-sided error term model but also in the two-sided error model. Further attention on this has been drawn to this matter and important extensions have been made by Farsi *et al.* (2003) and Greene (2005).

3.6 Empirical Literature on Stochastic Frontier Approach

One of the earliest applications of the stochastic frontier approach to efficiency estimation is the work by Tyler and Lee (1979). The paper, which followed the Aigner *et al.* (1977) model, fitted two factor stochastic frontier Cobb-Douglas functions to cross-sectional micro data for small scale Colombian firms from five manufacturing industries. The study demonstrated that considerable technical inefficiency was observed in the food products, apparel, and footwear industries. The other two industries, furniture and metal, however exhibited remarkable efficiency levels. It must be noted that the one-sided efficiency disturbance of the frontier production function estimated for the furniture and metal industries was swamped by the stochastic error. As a result, ordinary least squares and maximum likelihood estimates in these two cases were essentially the same.

Forsund and Hjalmarsson (1979) also applied the stochastic frontier approach on general milk processing in Swedish dairy plants. The main focus of that paper was to estimate technical change on the basis of a homothetic frontier production function specified to allow for variable scale elasticity. Their results indicated that rapid increase in optimal scale and a small capital saving bias characterized technical progress in the dairy industry. In order to describe the nature of technical progress, they used Salter's measures of bias. In that regard,

technical advance were utilized and explained in the context of Farrell's efficiency concepts. Sensitivity analysis carried out indicated that the removal of some production units, some of which were on the frontier of the sample, influences production function parameters.

Another related application of the model is the work by Albach (1980) on the industrial sector in Germany. The paper which formed part of a larger research project on empirical models of firm growth does not appear to follow developments in the stochastic frontier model, although the technique, dubbed *Gutenberg* type of production function, generally followed the stochastic frontier approach. The study reviewed results derived by related research and analyzed short-run and long-run behaviour of individual firms in the chemical industry of Germany. Albach (1980) made use of a concept, referred to as *putty-putty* technology, which made some simplifying assumptions and generally specified the production function to depend on labour and effective capital stock.

Page (1980) in a pioneering work analyzed technical efficiency and economic performance in three Ghanaian industries. The paper, which draws upon Farrell's technical and price efficiency concepts, determined the effect of price inefficiency on economic performance with particular reference to the logging, sawmilling and furniture industries in Ghana. Page (1980) utilized a linear programming technique, reported to have been developed by Richmond (1974), using ordinary least squares estimates of the Cobb-Douglas production function. The author found significantly high levels of technical efficiency across the three industries and suggested that age and structure of industries are likely factors responsible for those levels of efficiency. The parameters of the frontier production function estimated

yielded higher indices of price efficiency for logging and furniture industries, and significantly lower index for the sawmilling industry. This, the author noted, was explained by the underlying structure of the industries.

Kumbhakar (1988) applied the stochastic frontier model on a panel of railroads in the United States of America, after introducing a flexible functional form of the production technology into the model. Separate allocative inefficiency from random errors was introduced. The approach permitted a variable elasticity of output across firms. Input-specific and firm-specific inefficiencies were estimated together with firm-level technical inefficiencies. The author divided the entire sample period into five sub-periods and used maximum likelihood estimation to estimate the frontier function. The division therefore allowed for efficiency comparisons of the roads over the sub-periods. One of the key conclusions is the observation of extensive capital usage relative to the other two factors; fuel and labour.

Green and Mayes (1991) replicated for the United Kingdom what had already been done for the United States of America (Caves, 1988) and Australia (Harris, 1989) as part of a larger project aimed at examining technical inefficiency in manufacturing industries. The study was based on data for 151 industries, drawn from the Annual Census of Production for 1977. A Translog stochastic frontier production function was fitted for each industry, with the residuals decomposed into two components; the first measuring technical inefficiency and the other representing unobservable random factors. It was found that technical inefficiency was evident across a wide range of industries. Nonetheless, the average levels of technical inefficiency in the United Kingdom were a little lower than those found in the United States

of America, where there existed a positive correlation between the size of the industry and the level of inefficiency. With the industries in the USA significantly larger than their counterparts in the UK, the discrepancy was not out of place.

Hofler and Murphy (1994) applied a stochastic frontier regression technique to the estimation of reservation wages of employed workers. The study used the data collected by the Current Population Survey carried out in the United States of America in 1983. The authors established that the actual wage of a typical worker exceeded the reservation wage by 25 per cent, which was found usual with the notion that people turn up for job offers which pay above the reservation price. There was, however, no systematic relationship between the generosity of the unemployment insurance system run by the state and reservation wage, although a view appears to exist to the contrary that the more generous the state's unemployment insurance system, the higher will be the reservation wage of a typical worker.

Hay and Liu (1997) analysed firm efficiency using a frontier production function which allowed for the identification of long run relative efficiency of each firm, and short run departures from that level of efficiency. The study which was aimed at investigating the difference that competition makes on firm efficiency was based on panel data on 19 manufacturing sectors in the United Kingdom. The study subsequently identified three components of efficiency in the country's manufacturing sectors. They were technical change, average efficiency of each firm relative to the frontier, and the efficiency of each firm relative to its own 'best practice,' in each period. While short run declines in market

shares and profit induce the firm to improve its efficiency relative to 'best practice,' long run differences were found to correlate with differences in gross investment.

Abdulai and Huffman (2000) examined profit efficiency among farmers in the northern region of Ghana together with a possible link between farm and household attributes on one side and profit inefficiency on the other side. Profit efficiency is the level of efficiency exhibited by the farmers in their quest to maximize profits. Specifically, they used a normalized Translog stochastic profit function to examine the characterization of production efficiency among rice producers. On the average they found profit inefficiency rate of 27.4 per cent. Their analysis revealed that factors such as household head's education level, access to credit, proximity to extension services, and infrastructure had significant impact on profit efficiency exhibited by the producers. The authors also showed that certain non-farm activities, which they did not specify, had a considerable negative impact on profit efficiency.

Bigsten *et al.* (2000), in a comparative study involving four African economies, measured plant-level efficiency using stochastic frontier models in the manufacturing sector in these countries. The study also tested the relationship between exporting and firm-level efficiency. The authors, in order to distinguish the efficiency levels of exporters from those of non-exporters, divided the firms into two groups; initial non-exporters and initial exporters. The study observed that exporting firms tended to exhibit high efficiency levels than non-exporting firms over the survey period.

Specifically, they found that an additional year of exporting, for firms with previous history of exporting, raises the next period's efficiency by ten per cent, after controlling for other factors. And this efficiency gain was even larger for new entrants into the exports sector (Bigsten *et al.*, 2000). In order to verify whether the link between exporting and efficiency merely reflects self-selection or otherwise, they used non-parametric maximum likelihood to simultaneously estimate an efficiency function and a dynamic discrete choice equation of export market participation.

Piesse and Thirtle (2000) applied the stochastic frontier approach in the study of the changing productive efficiency of agricultural and manufacturing sectors of Hungary during the early years of that country's transition period. In the study, they used the stochastic frontier equivalent of measuring the Malmquist Total Factor Productivity (TFP) developed by Coelli *et al.* (1998). The Translog specification of the stochastic frontier model better fitted the firm-level panel data used than the Cobb-Douglas functional form. Their results showed that efficiency changes were dominated by technological regress, at around 4.8 per cent per annum in agriculture and 1.8 per cent in manufacturing. Consequently, the TFP was found to be driven by the negative technological change, falling at 5.1 per cent annually in agriculture and 8.7 per cent in manufacturing.

Contrary to the widespread view that African firms are inefficient, Soderbom and Teal (2002) found that dispersion in technical efficiency over firms is similar to that found in other countries. The study, which utilized a panel data on manufacturing firms in Ghana, was motivated by the need to investigate the relative importance of skills and the extent of scale,

technical and allocative inefficiency as potential factors behind poor performance in African manufacturing industries. They showed that the Cobb-Douglas production function adequately represented the technology employed by manufacturing firms in Ghana in particular and Africa in general. This therefore debunked the notion that technology used by firms in Africa is non-homothetic and hence the differences in factor choice across firms of varying size could not be explained by differences in technology.

Soderbom and Teal (2002) also found that age and tenure had a small impact on productivity while education had a rather large effect on productivity. In an earlier research, Soderbom and Teal (2001), enquired about the possibility of observed improvements in the manufacturing sector of some African countries being sustained to the point where 'the talk of African lions to match the Asian tigers would move from rhetoric to fact.' They found out by initially examining macroeconomic policies, that policies were the key pre-condition for growth of all exports. However it was not obvious from their analysis that improvements in policy along with lowering of transaction cost could unleash the desired growth in manufacturing exports.

More recently, Baah-Nuakoh (2003), inspired by Farrell's 1957 seminal paper, carried out a study using data on 16 manufacturing industries in Ghana to measure x-inefficiency levels in those firms. The study which also examined the connection between competition and x-inefficiency utilized data from surveys conducted by the Ghana Statistical Service. The relative performance of establishments within an industry were measured which formed the basis for creating a picture of the structure of the industry. An examination of the relationship

between competition and x-inefficiency by the study revealed that imperfect competition was a key pre-condition for the existence of much of the observed x-inefficiency. The levels of x-inefficiency revealed by the study were attributed to difficulties in procuring inputs, size of firm, and localization of industries.

Msuya and Ashimogo (2005) studied key determinants of technical efficiency observed among outgrower and non-outgrower farmers in the Mvomero District in Tanzania. The study also provided a description of technical efficiency of sugarcane production and the factors that affected this efficiency. The authors estimated stochastic frontier production and cost functions using cross-sectional data on 140 farmers, comprising outgrower and non-outgrower farmers. The study revealed a positive relationship between age, education, and experience on one side and technical efficiency on the other side using a Cobb-Douglas production and cost frontier functions.

Investigating how domestic supply constraints together with other firm attributes explained export intensity and market diversification in Africa, Yutaka Yoshino (2008) used bivariate models on firm-level data collected by World Bank Investment Climate Survey (ICS) from manufacturing sectors of seven countries. The study found evidence of strong scale effects both in export intensity and market diversification. Technology-related factors such as new vintage capital and internet access were also found to have positive impacts on export intensity and market diversification. Domestic constraints facing firms, in terms of inferior quality of infrastructure, were found to affect regional trade more than they do affect trade with other regions of the world.

Ajewole and Folayan (2008) used a stochastic frontier model to examine vegetable production efficiency in the dry season, and the potential for improving efficiencies of involved farmers. The study revealed that more than half of the sample farmers exhibited efficiency level of 70 per cent and beyond. Factors such as household size, education level, access to credit, and extension visits were found to have positive impact on technical efficiency. They also found that opportunity exist for increasing productivity and technical efficiency.

3.7 Conclusion

The theory that underpins production in economics has been explained in the chapter. This was followed by a discussion of estimating efficiency in production, particularly technical efficiency. These include, but are not limited to, deterministic and stochastic frontier approaches to estimating technical efficiency in production. The stochastic frontier approach, adopted for this study, has been thoroughly discussed. Developments in this approach, which mainly deal with decomposition and characterization of error term, have also been discussed. Estimating efficiency scores, closely linked to distributional assumptions of decomposed error terms, was also explained. The chapter also reviewed some empirical studies that employed the stochastic frontier approach to technical efficiency estimation.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter discusses the research methodology employed in this study. Issues looked at include the following; study population, study sample, study area, source and type of data, instrumentation, sampling procedure and sample size, pre-testing of instrument, selection and training of field assistants, and field data collection procedure. This chapter also describes the procedures to be involved in the estimation of the various stochastic production frontier models. The variables included in the model are defined and their a priori expected signs discussed.

4.2 Data Collection Processes

4.2.1 Study Population

The target population for the study is the non-traditional exports sector firms in Ghana. The Ghana Export Promotion Council (GEPC) defines non-traditional exports as all merchandise exports except gold and other minerals (in raw state), cocoa beans, timber logs and lumber, and electricity. As at 2007 the country had over 383 different non-traditional export products categorized into three main product groups, namely Agricultural products, Processed and Semi-Processed products, and Handicrafts (GEPC, 2007). The council also has a clientele base of over 3000 registered private-sector exporting firms organized into 15 Product Associations.

4.2.2 Study Sample

This study made use of a randomly selected sample of 60 non-traditional exports sector firms from the study population defined above. The selection was based on GEPC's 2008 Directory of Exporters and the membership list of the Association of Ghana Industries (AGI). The non-traditional exports sector firms used for the study engage themselves in the production of goods and services that fall within all the three major product groupings mentioned above (Agricultural products, Processed and Semi-Processed products, and Handicrafts). The proportion of firms selected from each of these categories was based on their respective export earnings in 2007. As at the end of year 2007, total non-traditional export earnings were US$1,164.51 million. Processed and semi-processed products contributed US$963.48 million to the amount (82.7 per cent) whiles agricultural products and handicrafts contributed US$197.24 million (16.9 per cent) and US$3.79 million (0.3 per cent) respectively. The 2007 performance was chosen mainly because of data availability.

4.2.3 Study Area

The Greater Accra region was identified as the focal area for the study. The selection of a single region was informed by a couple of reasons. The entire research covers a period of one year and this imposed a very crucial time constraint on the researcher. Financial and other logistical constraints also explain the selection of one region out of a total of ten. Nevertheless, the true representation of the entire population, it is believed, was not significantly impacted by the decision to focus on the Greater Accra Region. The reason is that more than half of all NTE firms are located in and/or have their offices/agents in this

region. It is important to emphasize that the study therefore did not necessarily exclude firms outside this region.

4.2.4 Source and Type of Data

The study used primary data collected directly from sample firms. Cross-sectional data was gathered using a structured questionnaire personally administered during a field survey. The data collected comprised the value of annual turnover (sales), annual cost of raw materials, end-of-year book value of fixed assets, annual cost of energy, and annual cost of labour, for the year 2007. The firms also provided information characterizing them as well as their export and or non-export operations. Such information included year of establishment, membership of producer/trade association, nationality of the firm, and whether a firm has free zone status or not. Other bits of information gathered during the survey were personal characteristics such as gender, educational level, and age of Primary Decision Makers in those firms.

4.2.5 Instrumentation

The main instrument that was used to collect data from the selected firms was structured questionnaire that was administered personally. This instrument was considered most suitable for the research survey based on the following reasons: (i) it provides uniform information which, most likely, enhances the compatibility of data (ii) it is easy to use to collect information from any respondent-representative of a firm (irrespective of his/her level of literacy).

4.2.6 Selection and Training of Field Assistants

Two Field Assistants were engaged in this survey to collect data. Selection of these assistants was based on their previous experience, knowledge of the local language, ability to understand and write in the language used in the study, and their availability during the survey period. The research assistants were trained to understand the purpose and objectives of the study as well as the survey. They were trained on the best interview techniques and on how to record the answers. They were also coached on how to introduce the survey to respondents, and the meaning of each question. The training of the field assistants was done by the student researcher.

4.2.7 Pre-Testing of Instrument

Pilot test of the instrument was carried out to verify its usefulness formed part of the field assistants' training. In order not to jeopardize the sample frame, firms used for this purpose were taken outside firms already selected to be used for the study. Field Assistants were closely monitored during the pre-test exercise in order to ensure that the questions were clearly understood by the data collectors and respondents, the survey was properly introduced, and responses properly recorded. The pre-test exercise was very helpful in the identification of relevant changes, both in terms of content and structure that greatly enhanced the usefulness of the instrument. The instrument was therefore fine-tuned after the pre-testing exercise.

4.3 Analytical Model

This study used both descriptive statistics and econometric methods. The descriptive statistics include the means, percentages and standard deviation that characterize various groupings of firms. The econometric method involved using both Cobb-Douglas and Translog stochastic frontier production functions to estimate the technical efficiency scores of non-traditional exports sector firms. It is pertinent to note that the Cobb-Douglas frontier is the restricted form of the Translog frontier, in which the second order terms in the Translog function are restricted to be zero. These functional forms have therefore been specified and estimated in order to establish a case for the choice of one over the other. The technology (inherent in the functional forms) employed by the firms have been estimated together with the technical efficiency effects using a two- stage estimation approach.

4.3.1 Theoretical Framework

The analysis in this research was based on standard production theory which assumes that the relationship between factors of production and output can be represented with a production function. The production function in general notation can be written as follows;

$$Q = f\{K, L\} \tag{4.1}$$

where Q represents a firm's physical output;

K represent the amount of capital used in the production of Q; and

L represents the amount of labour employed in the production process.

The production function indicates the maximum amount of output that can be produced using varying combinations of labor (L) and capital (K). Q is also referred to as the total physical

product (TPP). This production relationship can be expressed in several forms. They could be expressed either as linear, polynomial or Cobb-Douglas functional form. The latter can be modified to obtain the Translog functional form.

The marginal physical product (MPP) of an input is the extra output that results from increasing a particular input by a unit while holding other inputs as well as technology constant. The average physical product (APP) of a particular input, which is often a proxy measure of input efficiency, is total product divided by the quantity of referred input employed in production. It could also be defined as total output per unit of resource employed. The MPP and APP of labour are given below;

$$MP_L = \partial Q / \partial L = f_L \; ; \; AP_L = \frac{Output}{Labour} = \frac{Q}{L} = \frac{f(K,L)}{L} \qquad (4.2)$$

4.3.2 Stochastic Frontier

The stochastic frontier approach for estimating firm-level efficiency was used in this study. This approach, unlike other parametric frontier measures, makes allowance for stochastic errors attributable to statistical noise or measurement errors. The stochastic frontier approach decomposes the error term into two components; one captures the random effects outside the control of the firm (which is the decision making unit) and the other captures firm-level inefficiency.

The random error usually has a normal distribution whiles the inefficiency component takes on differing distributional forms, but its distribution is almost always asymmetric. The inefficiency component captures various factors that account for efficiency/inefficiency.

These factors include firm-specific knowledge, experience, skills, material bottlenecks, and other disruptions to production. Meeusen and van der Broeck (1977) and Aigner *et al.* (1977) assume that the asymmetric error has an exponential and a half-normal distribution, respectively. Both distributions have a mode of zero. Other proposed specifications of the distribution of the asymmetric error include a truncated normal distribution (Stevenson, 1980) and gamma distribution (Greene 1990 and 2003).

The stochastic frontier production function is illustrated with a firm which uses n inputs X_1, X_2, X_3, …, X_n denoted as X_i to produce output Y_i, given the technological and business environment. The transformation of inputs X_i, into output Y_i is characterized by the stochastic production frontier model depicted below. The specification shows the maximum output obtainable from various inputs used in production. The cross-sectional specification of the stochastic frontier model assumes the presence of technical inefficiency in production and is specified as:

$$y_i = \beta' x_i + \varepsilon_i; \varepsilon_i = v_i - u_i; u_i \geq 0; v_i \square N(0, \sigma^2) \qquad (4.3)$$

where i = 1,2,3, ..., N

y_i is the natural logarithm of observed output of firm i;

x_i is a (1 x k) vector of logarithm of inputs and other explanatory variables associated with firm i;

β is a (k x 1) vector of unknown parameters that will be estimated;

ε_i is the compound disturbance to the frontier;

v_i is the stochastic noise, with the usual Gaussian properties and represents other random factors such as strike, weather, and luck (Coelli *et al.*, 1998); and

u_i, represents the technical inefficiency, assumed to be distributed independently of v_i and satisfies the constraint $u_i > 0$.

The stochastic frontier approach to efficiency estimation distinguishes between the observed or actual output (y_i) and the unobserved efficient or frontier output (y_i*). The actual (observed) output is specified as follows;

$$y_i = \beta' x_i + v_i - u_i \tag{4.4}$$

While the unobserved frontier output is specified as

$$y_i = \beta' x_i + v_i \tag{4.5}$$

All variables are as per defined above (in equation 4.3) with u_i, the inefficient term, being equal to zero in the case of the frontier output. Under normal circumstances, the frontier output exceeds the actual output by the inefficiency term.

Jondrow *et al.* (1982) developed a predictor for u_i (as in equations 4.4 and 4.3). This predictor, for cross-sectional data, was computed as the conditional expectation of ui given the value of vi – ui. The predictor to be used in this research is the one proposed by Battese and Coelli (1988), which is a generalization of the Jondrow *et al.* (1982) predictor applicable to panel data.

In the second stage of the stochastic frontier approach, the inefficiency term u_i is specified as an explicit function of z explanatory factors. These factors are supposed to be firm-specific variables that influence firm-level efficiency. These inefficiency terms are assumed to be independently (but not identically) distributed as non-negative truncations of the normal distribution (or represented by a gamma distribution). Battese and Coelli (1995) proposes the following specification for the inefficiency effects model.

$$U_i = z_i\delta + W_i \tag{4.6}$$

where z_i is a (1 X m) vector of explanatory variables supposedly associated with technical inefficiency of firm i. It can include some input variables of the stochastic production function specified in equation 4.3;

δ is an (m x 1) vector of unknown coefficients to be estimated; and

W_i, is a random variable defined by the truncation of the normal distribution. It has a zero mean and variance of σ^2. The u_i, therefore, has a mean of $z_i\delta$ and variance σ^2. Alternative to the second stage of the approach, technical efficiency, computed from predicted inefficiencies, is rather regressed on these z explanatory factors.

There are quite a number of specifications that can result depending on the values taken by the coefficients of the explanatory variables. Battese and Coelli (1995) explained that if the first z-explanatory variable obtains the value of one and the coefficients of all other z-variables are zero, then the model specified in Stevenson (1980) and Battese and Coelli (1988,1992) results. Also if the coefficients of all z-variables are zero, then no relation can be established between the technical inefficiency effects and the z-variables. In such a scenario, the half-normal distribution originally specified in Aigner, Lovell and Schmidt (1977)

results. If interactions between firm-specific variables and input variables are included as z-variables, then a non-neutral stochastic frontier, proposed in Huang and Liu (1994), results. For the i^{th} firm, technical efficiency, given the level of technology and inputs, is defined in terms of the ratio of the actual output to the corresponding frontier output. Thus the technical efficiency of firm i in the context of stochastic frontier production function can be expressed as

$$TE_i = \frac{\beta' x_i + v_i - u_i}{\beta' x_i + v_i} \tag{4.6}$$

The technical efficiency of an individual firm i at time t can also be specified in terms of the expectation of the exponentiated technical inefficiencies as follows;

$$TE_i = \exp(-U_i) = \exp(-z_i\delta - W_i) \tag{4.7}$$

Given that U_{it} is a non-negative random variable (especially in the case of the half normal or truncated normal distribution), these technical efficiencies would lie between zero and unity, zero for completely inefficient firm and one for completely efficient firm.

4.4 Specification and Estimation of the Econometric Model

4.4.1 Specification of the Stochastic Frontier

In this sub-section, the specific stochastic frontier model estimated for the purposes of the study is stated. Two functional forms, namely Cobb-Douglas and Translog, have been identified. The identification of these forms was informed by previous studies using the stochastic frontier model, as reviewed in chapter three. Following Piesse and Thirtle (2000), the specifications of the stochastic frontier model using Cobb-Douglas and Translog are given below, respectively;

$$Y = \beta_0 + \beta_1 \ln FA + \beta_2 \ln RM + \beta_3 \ln EC + \beta_4 \ln LC + V - U \quad (4.12)$$

$$Y = \beta_0 + \beta_1 \ln FA + \beta_2 \ln RM + \beta_3 \ln EC + \beta_4 \ln LC + \beta_5 \ln FA \ln RM + \beta_6 \ln FA \ln EC + \beta_7 \ln FA \ln LC + \beta_8 \ln RM \ln EC + \beta_9 \ln RM \ln LC + \beta_{10} \ln EC \ln LC + V - U \quad (4.13)$$

In the specifications above, Y is the natural log of total value of gross output (measured in Ghana Cedis) per year. The explanatory variables are in natural logs and defined as follows:

FA represents end-of-year book value of fixed assets, measured in Ghana Cedis;

RM measures annual cost of raw materials employed by the firms, measured in Ghana Cedis;

EC measures annual cost incurred on energy by each firm, measured in Ghana Cedis;

LC measures annual cost of labour employed by the firms, measured in Ghana Cedi;

V and U are as per defined in equation 4.3 above and the *βs* are the parameters to be estimated.

The choice of monetary values of these variables over their physical values undoubtedly has some implications for the study, particularly with regards to interpretation, and they have been carefully noted. This choice was necessitated by the focus of the study. Since the firms that will be involved in this study produce different commodities, from fresh cut pineapples to articles of plastics, the use of physical values, especially with regards to output and raw materials used, have some implications regarding interpretation of results.

4.4.2 Stochastic Frontier Production Estimation

A two step procedure was used to estimate the stochastic frontier functions using the Maximum Likelihood method. The stochastic frontier and the inefficiency effects was estimated simultaneously using FRONTIER 4.1 econometric software developed by Tim Coelli. The Likelihood Ratio test was employed to determine which of the two functional specifications of the frontier model best fits the data.

4.4.3 Specification of the Technical Efficiency Function

The second stage of the stochastic frontier model regresses the computed firm-level technical efficiencies (using the technique of Battese and Coelli, (1988)) on firm-specific efficiency determinants. These efficiency scores were generated using the FRONTIER 4.1 econometric software. The specific efficiency function to be estimated in this study is specified as follows;

$$TE = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + W \qquad (4.14)$$

where TE_{it} measures technical efficiency that characterizes non-traditional exports sector firms and α_0 is the intercept.

The six firm-specific explanatory variables, Zs, are defined as follows:

Z_1 is a dummy variable that takes on 1 for foreign-owned firms and 0 otherwise;

Z_2 is a dummy variable that takes on 1 for joint ventures and 0 otherwise;

Z_3 measures the age of the primary decision maker in the firm;

Z_4 measures the age of a firm, represented by the difference between 2008 and the year in which the firm was established;

Z_5 is a dummy which measures sex of primary decision maker in the firm;

Z_6 is a dummy that takes on 1 for a primary decision maker who has completed a Tertiary level education and 0 otherwise;

Z_7 is a dummy that takes on 1 if a primary decision maker has completed a post-tertiary level education and 0 otherwise;

W is defined by the truncation of the normal distribution with zero mean and variance, σ^2. It captures random effects of measurement errors and exogenous shocks. Finally α_0, α_1, α_3, α_4, α_5, α_6 and α_7 are the unknown parameters to be estimated. This function was also estimated using the FRONTIER 4.1 econometric software. The a priori expectation of the explanatory variables is provided in Table 4.1 below.

Table 4.1: A priori expectation of the explanatory variables in the efficiency model

Explanatory Variables	Expected effect on technical efficiency
Z_1 – Foreign firm dummy	+/-
Z_2 – Joint venture dummy	+/-
Z_3 – Age of primary decision maker	+
Z_4 – Age of firm (year of establishment)	+
Z_5 – Dummy for gender of primary decision maker	+/-
Z_6 – Dummy for primary decision makers with tertiary level of education	+
Z_7 – Dummy for primary decision makers with post-tertiary level of education	+

4.5 Conclusion

The chapter has discussed the methodological framework to be used for the study. It has identified and clearly defined the study population, study sample, and study area. The source and type of data collected has also been explained. The particular stochastic frontier approach to technical efficiency estimation, to be used in this study, has also been identified and briefly explained. This was followed by the specification of the stochastic frontier model with technical effects components or function. The estimation techniques to be used have also been explained. A priori expectation of explanatory variables has also been provided.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the results of the study and discusses them. Among the issues discussed are the socio-economic and institutional characteristics of the Non-Traditional Export (NTE) Sector firms, a description of primary decision makers in those firms, and a descriptive analysis using the output and input levels. The chapter also discusses the results of the stochastic frontier model and the subsequent technical efficiency effects function, the main focus of the study.

5.2 The Socio-economic and Institutional Characteristics of NTE Sector Firms

This section describes the firms used in this study based on dimensions such as year of establishment, nature of firm, nationality of firm, and whether a firm has a free zone status or not. Other issues regard export orientation of the firms and their membership with producer/trade associations.

Among the 60 firms used in the study, the oldest was established in 1951 and the youngest was established in 2005. Thirteen of the firms were established before 1990 and 30 of them established between 2000 and 2005. The remaining firms were established between 1990 and 1999. The year of establishment profile of the firms is produced in the appendix of the report.

Out of the 60 firms used for the purposes of this analysis, 56 are limited liability companies, three of the firms are partnerships, and the remaining one is a sole proprietorship. Six firms, out of the 60, have Free Zones status while the remaining 54 do not have that status. Regarding the nationalities of these firms, 29 of the firms are owned by Ghanaians only and 17 of them were by foreigners only. The remaining 14 firms are joint ventures. The nationality distribution of the firms is provided in the appendix. A cross-tabulation of age range of the firms (represented by year of establishment) and nationality of the firms is presented in the table below.

Table 5.1: Cross Tabulation of Firms' Nationalities and Age Range

	Nationalities of Firms			
Age Range	Foreign Firms	Local Firms	Joint Ventures	Total
Before 1990	3	7	2	13
1990-1999	6	9	4	17
2000-2005	11	13	8	30
Total	17	29	14	60

Source: field survey, 2009

With regards to the export orientation of the NTE firms used for this analysis, nearly all (58 firms) have export experience. The West African sub-region was found to be the main export destination of these firms, followed by the European Union. This situation partly explains why the Agricultural sub-sector firms of the NTE sector were not excluded from the study. Majority of the firms are members of the Association of Ghana Industries.

5.3 Characteristics of Primary Decision Makers in NTE Firms

The NTE firms are overwhelmingly dominated by male primary decision makers. Out of the 60 firms used for this analysis, just thirteen of them had females as their primary decision makers. The age distribution of the primary decision makers varied widely. The youngest among them was 32 years old and the oldest was 73 years old. The age distribution of the primary decision makers is provided in the appendix to this report.

Out of the 60 firms used for the analysis, just a small number of firms (8) had their primary decision makers without a tertiary level degree or certificate. Thirty six primary decision makers had obtained a tertiary level degree or certificate. The remaining sixteen had postgraduate level degree or certificate. The distribution of highest level of education attended by the primary decision makers is shown in Table 5.4 below, whiles a cross tabulation of age groups of primary decision makers and their highest level of education attained is appended to the report. A cross tabulation of age groups and educational levels is shown in Table 5.2 below.

Table 5.2: Cross Tabulation of Age Groups and Educational Levels Attained by Primary Decision Makers (PDM)

	Highest Educational Level Attained by PDM			
Age Group	Below Tertiary	Tertiary	Post Tertiary	Total
31-40	3	14	4	21
41-50	2	4	8	14
51-60	0	12	4	16
61-70	1	5	0	6
71-80	2	1	0	3
Total	8	36	16	60

Source: field survey, 2009

5.4 Descriptive Analysis of NTE firms using Output and Input Levels

This section presents descriptive statistics of the variables that characterize the NTE firms. The statistics include arithmetic means, standard deviations, minimum values, and maximum values of the variables. These variables include annual turnover, value of total fixed assets, annual cost of raw materials, annual cost of labour, and annual cost of energy, measured in Ghana Cedis, used in the production process. The annual turnover of the firms ranged between GH¢16,600 and GH¢371,180, and averaged GH¢166,207. The end of year values of total fixed assets also varied from as low as GH¢10,040 to as high as GH¢1,635,592, and averaged GH¢336,696. The minimum, average, and maximum values of annual cost of labour for the firms are GH¢10,005, GH¢51,932, and GH¢82,534, respectively. Table 5.3 below depicts the descriptive statistics of these variables.

Table 5.3: Descriptive Statistics of Output and Input Levels, measured in Ghana Cedis

	Mean	Stand Dev	Min	Max
Turnover	166207.00	83319.4	16600.01	371180.00
Fixed Asset	336696.00	435286.5	10040.93	1635592.00
Raw Material	48491.00	27780.18	2579.99	95609.97
Energy	14734.00	1140.61	10070.71	15831.48
Labour	51931.99	20031.25	10004.97	82533.65

Source: field survey, 2009

5.5 Regression Results of the Frontier Model

Two econometric functions, namely Cobb-Douglas and Translog, as specified in Equations 4.12 and 4.13 were fitted to the data. The summary regression results are given in Table 5.4 below. The selection of one of these functional forms, for further discussion, is based on an adequacy ratio test of Cobb Douglas relative to a less restrictive translog. This is discussed below followed by a discussion on whether inefficiency exists in the non-traditional exports sector, based on the regression results.

Table 5.4: Maximum likelihood estimation of the stochastic production frontier models

Variables	Parameters	Cobb Douglas	t-ratio	Translog	t-ratio
Constant	β_0	0.6755	3.0445	-3.0651	-1.4287
LnFA	β_1	-0.1168	-2.9991	2.0078	1.7722
LnRM	β_2	0.0233	0.8340	-1.6675	-1.3992
LnEC	β_3	0.4083	2.6168	26.8543	1.5625
LnLC	β_4	0.4686	7.4350	-3.2925	-0.7635
LnFALnRM	β_5			-0.0282	-0.5050
LnFALnEC	β_6			-9.4701	-1.7330
LnFALnLC	β_7			1.0895	1.5684
LnRMLnEC	β_8			6.9184	1.1318
LnRMLnLC	β_9			-0.4491	-0.4922
LnECLnLC	β_{10}			0.4807	0.1317
Sigma-squared	σ^2	0.2281	0.6697	0.7204	0.8785
Gamma	γ	0.8088	2.9935	0.9465	16.5069
Log-likelihood	lnL	-10.9547		-7.5577	
No of iterations		39		57	

Source: field survey, 2009

The maximum likelihood method of estimation was used to estimate both the Cobb Douglas and translog production functions. The Likelihood Ratio (LR) test is used to select the appropriate production function adopted in the non-traditional exports sector. The LR test is a

statistical test of the goodness-of-fit between two models. A relatively more complex model is compared to a simpler model to see if it fits a particular dataset significantly better. The LR test, in this case, essentially tests the validity of the restriction imposed by Cobb Douglas, by assuming that the coefficients of the interactive variables are zero. In this regard, the Cobb Douglas function is assumed to be the null hypothesis (H_0) while the translog function is the alternate hypothesis (H_1). For a large sample size, the test statistic is found to follow the chi-square distribution with degrees of freedom equal to the number of restrictions imposed by the null hypothesis.

The likelihood ratio statistic is computed from the equation below.

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

where $L(H_0)$ is the log-likelihood of the Cobb-Douglas production function whiles $L(H_1)$ is the log-likelihood of the Translog production function.

$\ln[L(H_0)] = -10.9547$

$\ln[L(H_1)] = -7.5577$

$\lambda = -2\{-10.9547-(-7.5577)\}$

$\lambda = 6.7940$

The idea behind the test is quite simple; if the restrictions imposed by the Cobb Douglas are valid, the restricted and unrestricted logs of the likelihood functions should not be different. Asymptotically, the test statistic is distributed as the chi-square distribution with 6 degrees of freedom. This is because the Cobb Douglas restricts six variables in the translog function to be zero. The table value of obtaining such a chi-square value for 6 degrees of freedom at 95

per cent confidence level is 12.5916. This is greater than the calculated value of 6.7940, leading to the conclusion that the six interactive variables should be excluded from the model. In other words, the less restrictive translog function for the non-traditional exports sector is not valid. Detailed results of the Cobb Douglas function which is used to estimate the technical efficiency scores of firms are provided in Table 5.5 below.

Table 5.5: Maximum likelihood estimation of the Cobb Douglas stochastic frontier production function

Variables	Paramters	Cobb-Douglas	Standard error	t-ratio
Constant	β_0	0.6755	0.2219	3.0445
LnFA	β_1	-0.1168	0.0390	-2.9991
LnRM	β_2	0.0233	0.0280	0.8340
LnEC	β_3	0.4083	0.1560	2.6168
LnLC	β_4	0.4686	0.0630	7.4350
Sigma-squared	σ^2	0.2281	0.3406	0.6697
Gamma	γ	0.8088	0.2702	2.9935
Log-likelihood	lnL	-10.9547		
No of iterations		39		

Source: field survey, 2009

Another relevant test, related to the LR test, determines whether technical efficiency effects are simply random errors or really efficiency effects. Thus there is the need to check whether technical efficiency actually exists in the non-traditional exports sector. The key parameter in this regard is $\gamma = \sigma_u^2 / \sigma^2$, which lies between zero and one. If $\gamma = 0$, technical inefficiency

does not seem to exists, implying that the mean response function (ordinary least squares) is an adequate representation of the data. On the other hand, if γ is closer to unity, there is a high probability that the frontier model is appropriate. Given that $\gamma = 0.8088$, very close to unity, the frontier model is an adequate representation of the data. This implies that nearly 81 per cent of the random variation can be explained by inefficiency in production processes in the non-traditional exports.

It is important, at this point, to test for the significance of the estimated coefficients of the Cobb Douglas production function. The specific test to be considered here is whether the coefficients are significant or otherwise. Observation of the regression result, particularly the t-ratio of the estimated parameters, reveal that three out of the four variables are, individually, statistically significant. These are fixed assets, energy cost, and labour cost. The variable that measures the amount of raw materials employed in production was found not to be statistically significant.

The coefficients of three out of the four variables in the Cobb Douglas function turned out to be positive. These variables are cost of raw materials, energy cost, and labour cost. This implies that these factors of production have expected positive impact on production, as such increases in these factors lead to increase in production. The energy cost and labour cost variables had quite high t-ratios, indicating their statistical significance. The fixed assets variable, one of the variables whose coefficient was observed to be statistically significant, however, showed a negative sign, contrary to expectation. This seems to imply that as firms in the NTE sector accumulate more capital, the lower their output levels, which does not

appear to be plausible. This probably suggests that value of fixed assets accumulated by firms is not an appropriate proxy for capital consumption as it was earlier conceived.

5.6 Regression Results of the Technical Efficiency Function

The technical efficiency scores used as the dependent variable for the technical efficiency function were obtained directly from the econometric software used for the estimation. These efficiency scores, in terms of percentages, ranged from as little as 34 per cent to 95 per cent, and averaged 80 per cent. The full list of the technical efficiency scores is appended to this report but a distribution of the scores is shown in Table 5.6 below. The table indicates that the distribution of technical efficiency of NTE firms is heavily skewed to the right, with majority of the firms within 0.81 – 1.00 efficiency ranges. This therefore implies that majority of the NTE firms are technically efficient.

Table 5.6: Distribution of technical efficiency of non-traditional export firms

Technical Efficiency Range	Frequency	Percentage
0.31 – 0.40	1	1.67
0.41 – 0.50	4	6.67
0.51 – 0.60	6	10.00
0.61 – 0.70	8	13.33
0.71 – 0.80	19	31.67
0.81 – 0.90	14	23.33
0.91 – 1.00	8	13.33
Total	60	100.00
Mean T E	0.7889	
Minimum	0.3495	
Maximum	0.9496	
St. Deviation	0.1286	

Source: Survey data, 2009

Apart from firm specific characteristics, which will be discussed later, the observed technical efficiency differences could be due to some other factors, such as location and localization of NTE firms in a particular area, which may enable them get access to certain facilities.

The full regression results of the stochastic frontier model, including the technical efficiency function, using the Cobb Douglas functional form for the production function, is provided in Table 5.7 below.

Table 5.7: Maximum likelihood estimation of the stochastic production frontier model with technical efficiency effects model

Variables	Parameters	Cobb-Douglas	Standard error	t-ratio
Constant	β_0	0.6755	0.2219	3.0445
Ln FA	β_1	-0.1168	0.0390	-2.9991
Ln RM	β_2	0.0233	0.0280	0.8340
Ln EC	β_3	0.4083	0.1560	2.6168
Ln LC	β_4	0.4686	0.0630	7.4350
Efficiency Model				
Constant	α_0	-7.5601	36.9229	-0.2048
Foreign Dummy	α_1	0.0392	0.5166	0.0759
Joint Venture Dummy	α_2	-0.1069	0.6541	-0.1635
Age of PDM	α_3	0.0330*	0.0841	3.9230
Age of firm	α_4	0.0022*	0.0150	1.4712
Sex of PDM	α_5	-0.1054	0.3581	-0.2943
Graduate Dummy	α_6	0.7204 *	2.6003	2.7270
Postgraduate Dummy	α_7	1.7902 *	4.5378	3.9457
Sigma-squared	σ^2	0.2281	0.3406	0.6697
Gamma	γ	0.8088	0.2702	2.9935
Log likelihood		-10.9547		
No of iterations		39		

Source: Survey data, 2009

In the technical efficiency function above, the coefficients of four out of seven firm-specific variables are statistically significant, looking at the t-ratios of these variables. It is important to note that a correlation test between age of PDM on one side and graduate and postgraduate dummies on the other side, showed a low negative correlation (-0.01 and -0.16 respectively). These are age of PDM, age of firm, graduate dummy, and postgraduate dummy variables. Since the age variables are continuous variables, it implies that level of efficiency is positively influenced by age of the primary decision makers and age of firms, measured by the years they were established. In other words, the older the primary decision maker the more likely a firm will be technically efficient. Since experience levels of the PDMs could not be specified separately to explain for some of the variations in technical efficiency scores, the age of PDM variable might have captured this factor. Similarly, earlier established firms have a higher probability of turning out a high technical efficiency score than similar firms established later.

The other two statistically significant variables are graduate and postgraduate dummies. These dummy variables were defined with below tertiary education as the reference point. Consequently they are interpreted with reference to below tertiary education variable which was eliminated to avoid dummy variable trap. They both have positive coefficient, with the value of postgraduate dummy coefficient more than twice that of the graduate dummy variable. This implies that a primary decision maker with below tertiary education stands to enhance the technical efficiency of his firm when he/she furthers his/her education to tertiary level. The technical efficiency score stands to be more enhanced should the PDM even pursue post tertiary education.

5.7 Conclusion

In this chapter, the results of the regression analysis of the stochastic frontier model have been presented and discussed. Descriptive analyses of the characteristics of the NTE firms were also presented. The sizes of the firm, in terms of annual turnover, ranged from GH¢16,600 and GH¢371,180, and averaged GH¢166,207. The Cobb Douglas functional form of the production function was selected based on likelihood ratio test for the frontier model. Estimated efficiency scores for the firms were heavily skewed to the right, with majority of the firms within 0.81 – 1.00 efficiency ranges. These efficiency scores, in terms of percentages, ranged from as little as 34 per cent to 95 per cent, and averaged 80 per cent. This implies that the NTE sector firms are efficient. The efficiency scores were found to be positively influenced by age of firm, age of PDM, graduate dummy and postgraduate dummy variables.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides a summary and presents the findings and conclusions from the analyses and discussions. The chapter also presents policy and research recommendations that might be useful for academia, policy makers and other stakeholders in the non-traditional exports sector, in particular, and the export sector in general. It is also expected that the recommendations will help to improve the level of technical efficiency of the NTE sector firms.

6.2 Summary

The study was conducted to estimate the firm-level technical efficiency of the non-traditional exports sector in Ghana and to assess their determinants. The introductory chapter gave a background to the study and noted the specific objectives of the study which includes:

i. Finding out the characteristics of firms in the non-traditional exports sector.

ii. Determining the appropriate production function used in the non-traditional exports sector.

iii. Estimating the level of technical efficiency of the firms in the non-traditional exports sector.

iv. Estimating a technical efficiency function to ascertain factors that influence the technical efficiency of non-traditional sector firms.

v. Making appropriate policy recommendations based on the empirical results.

The study observed that the export sector has grown steadily after the economic reform programmes by the Breton Woods institutions. Non-traditional exports recorded a steady growth especially from 1993 through 2007. From as low as US$ 37.2 million in 1989, NTE hit total earnings of US$ 1164.5 million at the end of 2007. The NTE sector contribution to total export earnings was found to have grown persistently from 4.6 per cent in 1989 to 20.7 per cent in 2000 and further to 27.8 per cent in 2007. The performance of the NTE sector by market destinations also indicated that the European Union (EU) and the Economic Community of West African States (ECOWAS) together absorb more than three-quarters of the total output.

The study also observed that domestic and foreign efforts aimed at the diversification of the export base in the country have increased. Domestic efforts include government initiatives and other initiatives by non-governmental organizations such as Association of Ghana Industries (AGI), Federation of Associations of Ghanaian Exporters (FAGE), Private Enterprise Foundation (PEF), and the Ghana National Chamber of Commerce (GNCC). Donor efforts discussed in the study include the Trade and Investment Reform Programme (TIRP), Millennium Challenge Account (MCA), Ghana Trade Policy Project, Private Sector Development Programme (sponsored by DANIDA), and Joint Integrated Technical Assistance Programme (JITAP) among others.

The study reviewed some relevant literature on the theory of production and the measurement or estimation of technical efficiency. The discussion focused on three thematic areas; a review of the theoretical framework, developments in the efficiency estimation and

empirical literature. The discussion on theoretical literature focused on production theory, technical efficiency, economic efficiency, productivity and other recent developments that have ensued. Developments in the measurement of efficiency were discussed afterwards, followed by a discussion on the empirical literature on efficiency estimation.

The study discussed the methodological framework for the analyses and specified the specific functions estimated. It also detailed the type of data used for the study and the process employed in gathering them. The data for the study were collected directly from 60 firms involved in a survey. The data collected were for the year 2007. The study focused on the non-traditional exports sector firms in Ghana. The survey utilized a structured questionnaire and gathered general and specific information about each firm selected. Information gathered ranged from general firm characteristics, information about the primary decision maker, to output levels and levels of various inputs employed for the purposes of production. The study used FRONTIER 4.1 to estimate the stochastic frontier model with a technical efficiency function.

The study, in a nutshell, assessed and compared firm-specific characteristics of the non-traditional exports sector firms; investigated the level of technical efficiency of the firms and empirically estimated a technical efficiency function to determine factors that influence computed efficiency scores. This was done after estimating the production function that appropriately characterizes the technology and production process in the non-traditional exports sector. Two functional forms, namely Cobb Douglas and translog functions, were

estimated. The Cobb Douglas production function was chosen over the translog, based on likelihood ratio test.

The Cobb Douglas production function was specified to depend on total fixed assets at the end of the year, annual cost of raw materials used in the production process, annual cost of energy, and annual labour cost. The dependent variable for the function was annual turnover, a proxy for annual total output. The coefficients of three variables in the Cobb Douglas function turned out to be positive. These variables are raw materials, energy cost, and labour cost. This implies that these factors of production have expected positive impacts on production; as such increases in these factors will probably lead to increase in production. The energy cost and labour cost variables had quite high t-ratios, indicating their statistical significance.

The study employed a stochastic frontier approach in the determination of the level of technical efficiency in the non-traditional exports sector. The technical efficiency scores were computed based on actual or observed output and frontier or unobserved output levels of the firms in the sector, given the existing level of technology. The stochastic frontier approach to technical efficiency estimation accommodates random shocks to the production process. This is done by decomposing the error term into two parts. The first part of the error term is independently and identically distributed and uncorrelated with the regressors. The second part, referred to as the inefficiency term, is independently (but not identically) distributed as non-negative truncations of the normal distribution.

The technical efficiency scores were regressed on five firm-specific variables to ascertain factors that exert influence on technical efficiency. These variables included foreign firm dummy, joint venture dummy, age of firm, and age of PDM. The rest of the variables are age of PDM, sex of PDM, graduate dummy, and postgraduate dummy. All of these variables, except sex of the PDM variable, foreign firm dummy, and joint venture dummy were found to be statistical significant in explaining variations in technical efficiencies of NTE firms. These variables, which were found to be statistically significant, turned out positive coefficients.

6.3 Findings and Conclusions

This section presents specific findings and conclusions made by the study. The findings pertain to nature of firms, in terms of levels of inputs and outputs, as ascertained by the quantitative instrument employed by the study. The conclusions, on the other hand, regard the appropriate production function used in the NTE sector, and the firms' levels of efficiency and factors that influence the computed technical efficiency.

The annual turnover of the firms ranged between GH¢16,600 and GH¢371,180, and averaged GH¢166,207. The end of year values of total fixed assets accumulated by these firms also varied from as low as GH¢10,040 to as high as GH¢1,635,592, and averaged GH¢336,696. The cost incurred by the firms on energy and raw materials were also quite huge with differing magnitudes of variations. Energy cost varied from GH¢10,071 to GH¢15, 831 and averaged GH¢14,734. The cost of raw materials, on the other hand, ranged between GH¢2,580 and GH¢95,610 and averaged GH¢48,491. The minimum, average, and maximum

values of annual cost of labour for the firms were GH¢10,005, GH¢51,932, and GH¢82,534, respectively.

It was also found that the Cobb Douglas production function appropriately characterizes production process in the non-traditional exports sector. This conclusion was informed by a likelihood ratio test carried out after fitting two different functional forms to the data. These forms are the Cobb Douglas and the translog production functions. The Cobb Douglas production function was specified to depend on fixed assets, cost of raw materials, cost of energy, and labour cost. The dependent variable for the function was annual turnover, a proxy for annual total output.

The non-traditional exports sector firms were found to be technically efficient. Estimated efficiency scores for the firms were heavily skewed to the right, with majority of the firms within 0.81 – 1.00 efficiency ranges. These efficiency scores, in terms of percentages, ranged from as little as 34 per cent to 95 per cent, and averaged 80 per cent. The efficiency scores were found to be positively influenced age of firm, age of PDM, graduate dummy and postgraduate dummy variables.

6.4 Policy Recommendations

Two policy recommendations are being put forward for consideration by policy makers and other relevant stakeholders. The first regards level of education of primary decision makers in the NTE sector firms. The study concluded that for the firms studied, and by extension most of the firms in the non-traditional exports sector, the higher the level of education, the

more probable that the firm will exhibit higher technical efficiency score. The variable used measured the levels of formal education attained by the primary decision makers. However, there is the possibility that it also captured job-specific knowledge acquired by the PDM. It is therefore recommended that stakeholders, in conjunction with the academia, develop attractive programmes for further studies. These programmes will be more useful if they go beyond general topics treated to tackle job-specific knowledge.

Finally, the study found that old firms were more likely to have higher technical efficiency scores than new ones. Though it was, however, not clear what about old and new firms that created this disparity. It is therefore being recommended that stakeholders put in place policies and programmes that will ensure that NTE sector firms survive well into the future.

6.5 Recommendations for Further Research

Further research in this field can be directed in so many ways. Few recommendations are, however, being made here for consideration by academia and other stakeholders. The first regards the development of appropriate frontier models that will possibly encompass other components of the non-traditional exports sector/industry, particularly the time dimension. This is to say that it might be useful to apply the frontier approach of estimating technical efficiency to a panel data set. The deterministic approach can also be applied to this industry to find out its relevance.

The next recommendation for further research regards the extension of the model to account for levels of productivity and allocative efficiency. This can give more insight into non-

traditional exports sector performance. This study revealed some relevance of foreign and old firms in the NTE sector, in terms of enhancing firm-level technical efficiency. It was however not clear the particular features about these firms that enhanced their likelihood of exhibiting higher technical efficiency scores. It is thus being recommended that further studies investigate these issues.

Finally, the level of experience of the primary decision maker could not be specified to explain variations in technical efficiency, due to definitional and measurement problems. This can also be taken up in further studies. Other issues worth studying in this field regards whether the number of distribution outlets owned by firms and networking have any significance influence on the level of technical efficiency exhibited by the firms.

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APPENDICES

Appendix 1: Year of establishment profile of NTE firms

Age Range	Frequency	Percent
Before 1990	13	21.67
1990-1999	17	28.33
2000-2005	30	50.00
Total	60	100.00

Source: field survey, 2009

Appendix 2: Nationality distribution of NTE firms

Nationality	Frequency	Percent
Foreign-owned firms	17	28.33
Ghanaian-owned firms	29	48.33
Joint Ventures	14	23.33
Total	60	100.00

Source: field survey, 2009

Appendix 3: Age group distribution of Primary Decision Makers of NTE firms

Age Group	Frequency	Percent
31-40	21	35.00
41-50	14	23.33
51-60	16	26.67
61-70	6	10.00
71-80	3	5.00
Total	60	100.00

Source: field survey, 2009

Appendix 4: Distribution of highest level of education attained by Primary Decision Makers (PDM) of NTE firms

Educational Level of PDM	Frequency	Percent
Below Tertiary – Level	8	13.33
Tertiary – Level	36	60.00
Post Graduate	16	26.67
Total	60	100.00

Source: field survey, 2009

FIRM-LEVEL EFFICIENCY STUDY SURVEY

DEPARTMENT OF ECONOMICS

UNIVERSITY OF GHANA

Dear Sir/Madam,

Good day. My name is Alhassan Atta-Quayson, an M. Phil II student reading Economics at the University of Ghana, Legon. As a partial requirement for the completion of the programme, I am writing a thesis on the topic "Firm-level Efficiency in the Non-Traditional Exports Sector in Ghana." The purpose of the study is to employ econometric procedures to measure firm-level efficiency and total factor productivity of firms based on levels of output and input factors between 2005 and 2008. I am therefore undertaking a survey on exporting and non-exporting firms for the purposes of this study. Your firm has been selected to participate in this survey. **I wish to assure you that the information to be provided by you will be treated with utmost confidentiality**. All data will therefore be handled strictly confidential. If you require any further clarifications please do not hesitate to contact me on 0244986441 or at aattaquayson@yahoo.com

Thank you in advance for your cooperation.

A. General Information **Firm Identification Number** _____

Name of Firm:	
Contact Person:	
Position:	Date:
Address:	
Telephone:	Fax:
Email:	
Website:	
Year of Establishment:	
Nature of Firm: (a) sole proprietorship (b) partnership (c) limited liability company (d) other	
Nationality of Firm: (a) Ghanaians only (b) Foreigners only (c) Joint Venture (d) other	
Does your firm has a Free Zones Status?: (a) Yes (b) No	
Main Product	
Other Products	
Main Inputs:	
Farm Land Size (Agricultural Firms):	

1. Has your firm exported over the last 12 months? Yes No
2. If yes to Q1, to which destination do you export most of your output? (please tick your main export destination)

   ECOWAS Other African countries European Union USA Asia Others
3. Does your firm benefit from any Presidential Special Initiative? Yes No
4. Do you export to the USA under the African Growth and Opportunity Act (AGOA)? Yes No

5. Is your firm a member of any of the following? Please tick those that are applicable

   Association of Ghana Industry (AGI) Federation of Associations of Ghanaian Exporters (FAGE)

   Ghana Export Promotion Council (GEPC) Other(s)

6. Is your firm a member of any product association(s) registered with GEPC? Yes No

7. If yes please provide the name(s) of the association(s).

B. Information about Primary Decision Maker: Please provide information about the Primary Decision Maker in your firm. This person may be the sole proprietor/major partner/controlling shareholder of the firm

	Sex	Age	Highest level of education	Years of previous experience*
Primary Decision Maker				

* Please provide Primary Decision Maker's experience, in this or related field, prior to establishing this firm.

C. Annual Turnover and Value-Added Information: Please provide in Ghana Cedis (your best possible estimate)

	2005	2006	2007	2008
Annual Turnover				
Value-Added*				

*Value-Added is the difference between turnover (value of goods produced) and cost of materials used in production

D. Employment Information

	2005	2006	2007	2008
Total number of employees				
Number of Production Workers				
Number of Non-Production Workers				
Others				

E. Average Salary Information: Please provide for these groups of workers the average MONTHLY salaries in Ghana Cedis (your best possible estimate)

	2005	2006	2007	2008
Production Workers				
Non-Production Workers				

F. Capital Consumption Information: Please provide the values of end-of-year fixed assets and annual depreciation in Ghana Cedis (your best possible estimate)

	2005	2006	2007	2008
Fixed Assets				
Depreciation				

G. Information on Raw Materials: Please identify three main raw materials used in your production process and provide annual cost incurred on them in Ghana Cedis (your best possible estimate)

Raw Materials	2005	2006	2007	2008

H. Energy Consumption Information: Please provide the annual cost incurred by your firm on the following in Ghana Cedis (your best possible estimate)

	2005	2006	2007	2008
Electricity				
Petrol				
Diesel				
Other (specify)				

I. Information on Other Expenses: Please provide annual cost incurred on the following expenditure items in Ghana Cedis (your best possible estimate)

	2005	2006	2007	2008
Transportation				
Research and Development				
Communication				
Advertisement				
Rent				

I am most grateful for your cooperation and assistance. Thank you.