EFFICIENCY OF BOTSWANA MEAT COMMISSION

Geraldine Nkombeledzi

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By

Geraldine Nkombeledzi

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CERTIFICATION

The undersigned certifies that he has read and hereby recommend for acceptance by the University of Dar es Salaam a dissertation titled: ***Efficiency of Botswana Meat Commission***, in fulfilment of the requirements for the award of degree of Masters of Arts (Economics) of the University of Dar es Salaam.

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(Supervisor)

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I, Geraldine Nkombeledzi, hereby declare that this dissertation is my own original work that has not been submitted and will not be submitted to any other University for a similar or any other degree award.

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DEDICATION

This dissertation is dedicated to grandparents Mr. Baathudi Z. Nkombeledzi and Mrs. Sarah H. Nkombeledzi who assumed the role of being parents after my mom died 13 years ago.

ABSTRACT

Over the years BMC has been characterised by a series of fluctuations in its throughput and also the inability to operate at full capacity. An interesting detail is that, demand for beef and beef products has risen as evidenced by a rise in domestic consumption. BEDIA (2008) reports that, the number of cattle supplied to BMC over the years has declined, while on the other hand, domestic consumption has increased and local butcheries have attracted an increasing number of cattle made available for slaughter: as a result throughput at BMC abattoirs has declined leading to excess capacity.

Given that, Botswana has higher potential of meat production than it actually produces, there is therefore a need to determine BMC level of efficiency and identify possible causes of inefficiency so as to reduce existing excess capacity and improve its performance. This study employed Stochastic Frontier Analysis to assess technical efficiency of Botswana Meat Commission. The results indicate that BMC is not technically efficient. The study also used Ordered Logit to assess factors having an influence on efficiency.

Factors that were found to have influence include material input, producer prices and exchange rate. In consideration of the potential that the sector possesses such as diversification of the economy and export earnings among others, strategies that can enhance BMC performance must be fully explored. Options that can be explored include; opening up of the market so that producer prices are competitively set and further processing of by products which can be outsourced so that the commission concentrates on efficient production of beef and beef products.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AGOA	The African Growth and Opportunity Act
BCL	Botswana Copper-Nickel Limited
BDC	Botswana Development Corporation
BEDIA	Botswana Export Development and Investment Authority
BMC	Botswana Meat Commission
BoB	Bank of Botswana
BPC	Botswana Power Cooperation
BSE	Botswana Stock Exchange
CBPP	Contagious Bovine Pleuro-Pneumonia
CDM	Cold Dressed Mass
CSO	Central Statistics Office
DEA	Data Envelopment Analysis
DoT	Department of Tourism
DTCB	Diamond Trading Company Botswana
EPA	Economic Partnership Agreement
EPP	Export Parity Pricing
EU	European Union
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome

MFDP	Ministry of Finance and Development Planning
MMEWR	Ministry of Minerals, Energy and Water Resources
NBFIRA	Non-Bank Financial Institutions Regulatory Authority
NDP	National Development Plan
OECD	Organisation for Economic Cooperation and Development
SFA	Stochastic Frontier Analysis
SPS	Sanitary and Phytosanitary Standard
UN	United Nations
UNDP	United Nations Development Programme

CHAPTER ONE

INTRODUCTION

1.1 Background

Botswana is branded for having one of the world's highest growing economies over the past decades. Prior to gaining independence in 1966, Botswana was counted among one of the poorest countries in the world with an economy that was largely based on agriculture and some tourism, Owusu *et al.* (1997). However the share of agriculture has gradually declined with the mining industry taking over. Mineral resources combined with prudent economic management led to rapid growth which improved Botswana's ranking from a low income to a middle income country, UNDP (2009).

Between 1965 and 2005, real annual economic growth averaged 9% per year. Per capita income increased from USD 5,700 in 2006/06 to USD 7,000 in 2006/07. From 2005 to 2011 the average annual GDP growth was 3.15% and it reached a historical high of 17.30% in March 2010 and record low of -14.80% in March. The key drivers of the economy are Mining; contributing 26% of Gross Domestic Product, Government services contributing 18% of Gross Domestic Product, Trade, Hotels and Restaurants with 14% and Banks, Insurance and Business services which contributes 12% to Gross Domestic Product, BoB (2010). All these accolades have been made possible through pursuit of sound economic policies. OECD (2007) asserts that, policy

stance has been guided by vision 2016[1], which sets a broad policy agenda for poverty reduction and macroeconomic stability. The key objective of fiscal policy in Botswana is careful management of expenditure to achieve social objectives without crowding out the private sector. The principal objective of monetary policy in Botswana is to achieve a low and stable level of inflation that will spur growth and competitiveness.

Botswana's efforts to maintain the good track record of economic performance and management have not gone unnoticed. It has constantly performed well in terms world rankings. Ministry of Finance and Development Planning (2012) reports that in the World Bank "Doing Business Report", that investigates the practices that enhance business activity and those that constrain it, Botswana was ranked third in Africa and 52nd out of 183 countries surveyed. Additionally the Standard & Poor's and Moody's Investors Service in November 2011, changed the outlook on Botswana's sovereign ratings from negative to stable. The ratings reflect the continued confidence in the capacity and resolve of the Botswana authorities to maintain the good track record of prudent macroeconomic management.

In order to ensure that all citizens share the fruits of economic growth equitably, the government provides a number of social safety nets. The safety net provision includes the availability of a universal non contributory old age pension which has risen over the years to account for inflation. Others include the destitute allowance, orphan care programme, the vulnerable group feeding scheme, primary school feeding programme

[1] Vision 2016 is Botswana's strategy to propel its socio-economic and political development into a competitive, winning and prosperous nation. Seven key goals have been developed to achieve this.

and various drought relief programmes, NDP 10 (2007). It is also noteworthy to point out that Botswana is one of the few privileged countries that provide free health services and highly subsidised education.

Another impressive trait about Botswana is that, it is one of the few countries that managed to avoid the alleged curse of natural resource based economy namely the Dutch disease. Mapoise (2005) says that, the Dutch disease effect arises where the rapid development of one sector in this case the export mineral sector with its substantial revenue for government, crowds out all except the most robust activities, thereby serving to obstruct industrial development elsewhere possibly on a permanent basis. Dutch disease was avoided mainly because the government had taken care not to spend more than the economy could absorb and to avoid the boom and the bust cycle to mineral-led economies. This strategy composed of a set of rules for smoothing public spending in the face of revenue shocks and accumulating financial assets for future generations.

Although Botswana has been doing well, it is highly susceptible to external forces. This is so because it remains highly dependent on diamond production, which accounts for about three quarters of exports, one third of GDP, half of government revenues and 3% of total formal sector employment while agriculture; driven by the livestock subsector and beef exports accounts for only 2% of GDP but contributes a substantial proportion of rural income and 20% of total employment, UNDP (2009). Diamonds are non renewable natural resources which imply that with time they will be depleted; hence they are unreliable and unsustainable. Another limitation is that, it is a luxurious

commodity which makes it highly dependent on the state of economic performance. As a result of the 2007 economic recession, Botswana's economy was hardly hit because of a huge decline in diamond sales and the end result was that in 2009/2010 financial year Botswana registered a budget deficit after years of budget surplus. Additionally the mining sector is heavily capital intensive hence contributes relatively little to employment.

Given the limitations associated with heavy reliance on diamonds for both export earnings and revenues, the government has embarked on strategies to diversify the production base of the economy. In order to spearhead diversification, the government has identified areas to focus on for enhanced economic growth and diversification, UN (2010) asserts that six hubs were created. The hubs include the education hub, innovation hub, agricultural hub, diamond hub, medical hub and transport hub. The education hub seeks to increase the quality and relevance of education at all levels and thereby makes Botswana more competitive, the innovation hub is aimed at creating a platform for local and foreign businesses engaged in R&D and knowledge intensive activities. The agricultural hub aims at encouraging participation in farming, mentor farmers on agribusiness skills and endeavour to commercialise the agricultural sector so as to make it sustainable. The diamond hub intends to establish a diamond trade centre for rough/polished diamonds and to promote sustainable downstream activities such as polishing and jewellery making. The medical hub hopes to identify projects and programmes that will make Botswana a centre of excellence in the provision of healthcare services. Finally the transport hub seeks to reposition the country as a

regional hub for rail, road and air transport and to support a competitive transport and logistics industry in Botswana.

Agriculture though faced with many challenges that cause its performance to either stagnate or decline has been recognized as a potential sector that will aid the country in its diversification endeavours. The agricultural sector continues to play a vital role in Botswana and retains the potential for economic diversification. Unfortunately it continues to be plagued by its dependence on rainfall, OECD (2007). The sector's contribution to the Gross Domestic Product (GDP) has been decreasing over years to less than 3 percent in recent years. However, the livestock sub sector's contribution to the economy through foreign earnings has been significant.

Although livestock production in Botswana contributes a significant proportion in foreign earnings, it is a small player in the global market. The world's five largest beef exporters are Brazil, Australia, Argentina, USA and Canada, which supply about 80% of world exports. In terms of beef exports from domestic production, Argentina is the main supplier and, therefore, its export price represents the average competitive beef price in the world market Otieno *et al*. (2008). At present, Africa remains a relatively smaller player in global export markets for meat products. Beef is by far the largest source of export revenues for Africa, totalling nearly US$ 100 million in 2003, Rich (2004). In Africa, the main beef producers and exporters are Namibia, Botswana and South Africa, which represent models of successful export-led livestock systems in the continent, Halderman and Nelson (2005).

1.1.1 Livestock Farming in Botswana

Botswana is a landlocked country with a population of over 2 million, majority of them live in rural areas and derive their livelihood from agriculture and other rural subsistence activities. Traditionally agriculture was the main form of economic activity for majority of Batswana, Nthoiwa and Tselaesele (2010). Agriculture serves as an important source of living for most Batswana through cattle farming. Cattle production remains an important factor in the rural economy as a source of income, employment and investment opportunities, about 25 % of rural households derive their livelihoods from cattle, Stevens and Kennan (2005). Agriculture contributed 2.3% of GDP in 2003/04 out of which 70-80% is attributable to cattle production, Feasibility study for the manufacturing of beef products and beef-by products in Botswana report (2006).It also has strong linkages with the rest of the economy as a supplier of inputs for meat processing, leather and other industries Aina (2007).

Prior to the emergence of the diamond industry Botswana's economy was dominated by agriculture, particularly cattle rearing. The structure of the economy has since changed enormously, with a steep decline in the importance of agriculture, a corresponding rise in the role of mining and also growth in other sectors, United Nations (2002). Agriculture's share to GDP sharply declined from 42.7% in 1966 to 1.6% in 2006/07 out of which 80% is attributable to cattle production, Mapitse (2008).

Botswana is estimated to have a population of 2.5 million cattle. Cattle are kept under two production system: traditional/communal and commercial. The main type of

production is in the communal system, which accounts for 86% as compared to 14% of commercial system, National Development Plan 10 (2007). Studies have shown that in recent years there has been a structural change in the sector with the share of the communal/traditional production system rising to upwards of 95 % of the national herd, National Development Plan 9 (2003). Since agriculture has been the main employer in the rural areas, and livestock being the major contributor to the agricultural GDP, the sector has remained important to the government strategy of rural development and food security. The Government of Botswana has since independence developed and implemented policies that sought to improve livestock productivity to maintain and increase beef and beef products exports, sustainable diversification of the sector, and employment creation, Mapitse (2008). Some of those policies include establishment of Botswana Meat Commission.

1.1.2 Botswana Meat Commission

Botswana Meat Commission is a parastatal that was established in 1966 to promote development of the country's beef and related products globally. By law BMC has a monopoly on the export of both live cattle and beef products, which means that other players in the industry must obtain permission from the commission to export these products and permission is rarely given. In addition to its export monopoly, the BMC also sells beef products in the local market directly to retailers, Feasibility study for the manufacturing of beef products and beef-by products in Botswana report (2006).

Botswana Meat Commission can be viewed as a strategic monopoly therefore the government is compelled to intervene to address performance and financial difficulties

issues. The government has intervened through heavy subsidies into the sector, very lenient tax system, artificially high producer prices and provision of heavy livestock specific infrastructure, Stevens and Kennan (2005). In order to address a decline in export earnings (from US$ 63 million in 1998 to US$ 30 million in 2003), the Botswana Meat Commission (BMC) increased producer prices by 40% while the government initiated policy amendments to stimulate beef exports (AGOA, 2006). In addition, although various export strategies are pursued by the country in different markets, single-channel marketing through the Botswana Meat Commission is preferred when exporting to the EU on the basis of high fixed costs of compliance with zoosanitary and supply chain requirements. To promote beef exports, producers in Botswana receive a 40% external tariff and the country also places a ban on imports of cattle and fresh meat from South Africa (Stevens and Kennan, 2005).

1.2 Statement of the Problem

Over the years BMC has been characterised by a series of fluctuations in its throughput[2]and also the inability to operate at full capacity. An interesting detail is that, demand for beef and beef-by products has risen as evidenced by a rise in domestic consumption. BEDIA (2008) reports that, the number of cattle supplied to BMC over the years has declined, while on the other hand, domestic consumption has increased and local butcheries have attracted an increasing number of cattle made available for slaughter; as a result throughput at BMC abattoirs has declined leading to excess

[2] Total output in a unit period under normal operating conditions

capacity. The decrease in the cattle supplied to BMC by farmers it is a result of price differentials.

One would anticipate a rise in demand to be accompanied by an increase in throughput, but that seems not to be the case instead BMC is operating below full capacity. Botswana has higher potential of meat production than it actually produces. This implies that, there is underutilisation of economic resources, and overtime, BMC production has declined. Given the decline of cattle of supplied at BMC, there is therefore a need to determine BMC level of efficiency and identify possible causes of inefficiency, so as to reduce existing excess capacity and improve its performance.

1.3 Research Questions

The research questions are:

(i) How has BMC been performing in the years 1979-2009?
(ii) What is the technical efficiency status of BMC?
(iii) What are the causes of inefficiency?

1.4 Objectives

The general objective of the study is to examine the technical efficiency of Botswana Meat Commission.

The specific objectives are:

(i) To examine performance of BMC from 1979-2009

(ii) To ascertain efficiency status and causes of inefficiency in the beef industry.

1.5 Significance of the Study

The main significance of this study is that it will add to the existing limited literature on performance issues of Botswana Meat Commission and will also open grounds for further studies on the related issue.

Moreover it will also assist BMC in coming up with policies or strategies that will help improve the performance and efficiency of their operations. Lastly it will give insight on how the manufacturing industry performance, which will be important for policy making and reforms concerning industries.

1.6 Organization of the Study

The study is organized into six chapters. Chapter Two focuses on the profile of Botswana economy. Chapter Three follows which deals with the literature review which is categorized into theoretical and empirical literature; Chapter Four emphasizes the methodology which contains the data sources, measurement of variables and estimation technique. Chapter Five presents the econometric estimations and analyses of the results. Lastly Chapter six offers the conclusion and policy implication.

CHAPTER TWO

BACKGROUD OF BOTSWANA MEAT COMMISSION

2.0 Introduction

This chapter presents information on Botswana economy coupled with background information on the geographic and demographics of Botswana. It also provides information on macroeconomic indicators and main economic sectors. Finally it gives insights on formation, setup, performance of Botswana Meat Commission and challenges faced by the commission and policy responses by both the government and the commission.

2.1 Botswana Economy

2.1.1 Geographic and Demographic Background

Botswana is a landlocked country of 582,000 square kilometres. It is situated in Southern Africa and it is bordered with Zimbabwe, South Africa, Namibia and Zambia. Big part of the country is covered by the Kalahari Desert and only 5% of the land area is considered arable. Botswana is a relatively flat country with low rainfall and high temperatures. Due to the semi-arid climate, most rivers and streams in Botswana are non-perennial, UNDP (2009). Botswana comprises of approximately 34 different ethnic groups. From the recent 2011 Population and Housing Census, population has realised a growth rate of 1.9% between 2001 and 2011 from 1,680,863 to 2,038,228, MFDP (2012). Many factors are said to have contributed to the general decline in Botswana's annual population growth rates HIV/AIDS cited as one.

Botswana gained its independence from the United Kingdom in 1966. It is a tri-cameral democracy based on the separation of the legislative, executive and judicial powers. The President is both the head of state and head of government and is elected by the National Assembly for a five-year term, UNDP (2009). The President is restricted by the constitution to serve no more than two full terms in office. The current president, Lieutenant-General Seretse Khama Ian Khama, came into office in March 2008. Prior to that, Festus Mogae was President from 1998 to March 2008. Since independence four presidents have served the nation all from ruling Botswana Democratic Party which has been in power since independence.

2.1.2 Performance of Botswana Economy

Botswana economy has recorded impressive growth rates. Gross domestic product (GDP) growth has averaged about 9.2 % per annum in real terms over most of the post-independence period. However, much of this growth has been due to the sustained and rapid expansion of one sector – the mining sector – and of government, which has largely been financed by the proceeds of mineral revenues, Siphambe (2007).

The currency used is called Pula which means *rain in Setswana*. It was adopted in 1976 replacing the South African Rand. Despite the 7.5% and 12% devaluation in 2004 and 2005 respectively, it still remains one of the strongest currencies in Africa, Standard and Poors (2010).

The economy is highly dependent on few sectors and it has been identified to be not well diversified. The mining sector has been the dominant sector since the discovery of diamonds. Mining industry, especially diamonds have helped in the expansion and accounts for more than one-third of GDP and for 70-80% of export earnings. Over the years sectors such as tourism, financial services, subsistence farming and manufacturing have shown growth and have become other key sectors of the economy.

Despite the impressive performance, Botswana is grappling with significant unemployment rate, HIV/AIDS pandemic and poverty. MFDP (2012) reports that, unemployment continues to be stubbornly high. According to the Botswana Core Welfare Indicators (Poverty) Survey of 2009/10 (2011) overall unemployment rate is estimated at 17.8 % of the total labour force compared to 17.5 % as indicated in the 2005/06 Labour Force Survey. The 2005 Botswana AIDS Impact Survey estimates the national HIV prevalence rate at 17.1 % (19.8 % for females and 13.9 % for males). People living in towns had a higher prevalence rate (21.3 %) than those living in cities (20.2 %) and in rural areas (15.6 %). Regarding poverty, Botswana Core Welfare Indicators (Poverty) Survey of 2009/10(2011) indicates that the number of individuals falling below the Botswana Poverty Datum Line declined from 30.6 % of the population in 2002/03 to 20.7 % in 2009/10, which is still high considering economic performance of the country. Given the economy's growth, income inequality still remains a concern.

2.1.3 Performance Macroeconomic Indicators

Botswana's real GDP growth rate has averaged 9.2% per annum over the 1966-1996 period, which was the highest sustained growth in the world. For the period 2000-2008, the average growth rate was 5.01%. In 2009 GDP growth reached its minimum value of -4.93% due to the economic recession. The economy has since recovered with GDP growth of 7.2% in 2010 and 7.8% in 2011, MFDP (2012).

The exchange rate system in place is the crawling band exchange rate mechanism which was introduced in May 2005. In this mechanism, the Pula is pegged to a basket of currencies of major trading partners comprising the IMF's Special Drawing Rights and the South African Rand, BoB (2008). Consistent with the crawling peg exchange rate arrangement, the Pula depreciated in 2011. As a result, the trade-weighted exchange rate depreciated by 2.5% in the 12 months to December 2011, contributing to relative stability of the inflation-adjusted exchange rate, which appreciated by just less than one percent over the same period. Further, in the 12 months to December 2011, the Pula depreciated against major international currencies while it appreciated by 5.8% against the South African Rand. Overall depreciation of the Pula against the SDR was 13.8%, MFDP (2012).

Prior to 2008 the monetary policy involved the setting of a yearly inflation objective but with effect from 2008 the Central Bank adopted a rolling three-year monetary policy framework in which the medium-term inflation objective is set. Monetary policy action was guided by the medium-term inflation forecast, which is revised on a regular basis, taking into account a broad range of inflation determinants, including credit growth. Based on the new monetary policy framework, the 2008 Monetary

Policy Statement announced a 3-6% medium-term inflation objective, a range that was reaffirmed following a review at mid-year. During the first half of the year 2008 inflation rose rapidly to a peak of over 15%, the highest in fourteen years due to a number of factors, including the rise in prices of food and fuel prices, as well as higher domestic demand. In an effort to restrain the second-round inflationary effects of the supply shocks and restrain spending while encouraging saving, the Bank Rate was increased by 50 basis points each in May and June to 15.5%. Inflation began to subside by mid-year due to a progressive fall in fuel prices and continued weakening of the global economy, resulting in an improvement in the inflation outlook. These developments prompted a reduction in the Bank Rate to 15% in December, BoB (2008). In 2010, domestic inflation rose from 7.4% to 9.2% in 2011, remaining above the Bank of Botswana's objective range of 3 to 6%. High inflation was mostly due to the impact of the increase in some administered prices, namely public transport fares, electricity tariffs and fuel prices, MFDP (2012).

2.1.4 Sector Performance

At independence agriculture was the mainstay of the economy but since the discovery of diamonds, the mining sector is now the key sector in the economy. Over the years other key sectors have grown and their share contribution to GDP has been significant. These sectors include manufacturing, financial services and tourism. Table 2.1 shows the sectoral performance of the economy as a percent of GDP.

Table 2.1: Sectoral Performance as Percent of GDP

Year	Mining	Agriculture	Manufacturing	Financial Services	Tourism
1966	0	39	8	2	5
1975	12.5	25.4	6.9	2	8
1977	15.2	21.3	5.8	6.9	8.1
1982	32	8.9	6.7	6.3	6.8
1990	51	4.8	5	6.1	5.2
2000	33.7	4.2	6	10.8	9.7
2007	40	2	4	4	12
2008	26	3	4	12	14

Source*:* Constructed from BoB annual reports 2007-08 and Mapoise and Matsheka(2001)

2.4.1.1 Mining Sector

The mining sector has over the years played a critical role in the economy and it is a significant contributor to gross domestic product. Botswana's portfolio of mineral reserves includes diamonds, coal, copper, nickel, cobalt, gold and soda ash. Botswana is the world leading producer of gem quality diamonds. The first recorded diamonds discovery was in 1955 and production started in 1971 at Orapa mine. There are three diamond mines namely, Orapa, Letlhakane and Jwaneng and are all open-pit[3] kimberlite mines, Modise (2010). The mining sector has been the largest sector in Gross Domestic Product since early 1980s. In 1995/96 mining contribution to GDP was 32.5% and in 2008/09 the contribution stood at 26%, Ministry of Minerals, Energy and Water Resources (2010).

Diamonds are currently mined by Debswana Diamond Company. All the mining ventures are operated as private companies although government has significant

[3] Method of extracting rock or minerals from the earth by their removal from an open pit or borrow and it is used when deposits are commercial useful.

shareholding. With respect to the Debswana Diamond Company, it is owned on 50:50 basis between Botswana government and De Beers Centenary AG of Switzerland. Most of the value of diamonds is derived from gem diamonds as opposed to industrial diamonds. Gem diamonds account for approximately 20% of production and 80% of value. The cost of diamond production relative to value is low and consequently economic rents are high, Modise (2000).

Over the years diamonds exports have been in raw form; rough/ unpolished diamonds. In order to diversify the sector and increase returns, in March 2008 Diamond Trading Company Botswana (DTCB) was launched to sort, value, market and distribute aggregated diamonds in Botswana. This move was intended to act as an anchor business for the development and nurturing of a fledgling secondary diamond industry in the country. Plans are well afoot to install an aggregation facility in the DTCB building. This means mixing diamonds from different mines and countries with similarities. In April 2008, a Diamond Hub was established with the intention of strengthening the position of Botswana as a meaningful player in the world diamond industry. The Diamond Hub will work towards building, strengthening, regulating and monitoring the secondary diamond industry; which include rough and polished diamonds trading centre, diamond cutting and polishing centre, diamond set jewellery manufacture, and diamond ancillary services, Ministry of Minerals, Energy and Water Resources (2010).

After diamonds, Botswana's most important mineral product is copper-nickel matte produced at the long-established BCL Mine and smelter in Selebi-Phikwe east of the

country. Tati Nickel Mining Co (TNMC) is owned by Norilsk Nickel (85%) and Botswana Government (15%). The Matte produced by the BCL smelter is refined in Norway.

Botswana has large untapped reserves of semi-bituminous coal but the sole mining operation is the Morupule Colliery in eastern Botswana, which produces just under one million tonnes per year. This coal mainly supplies the Morupule thermal power station operated by the Botswana Power Corporation (BPC), BCL and Botswana Ash (BOTASH). Botswana is endowed with vast coal resources of about 212 billion tonnes, which up to now have not been fully exploited. Interest on these deposits has been concentrated on the Morupule, Mmamabula and Moijabana / Kgaswe coalfields. These are all thermal coals for direct feeding to a power generating station or that can be washed and sold onto the international steam coal markets.

The Sua Pan project, commissioned in 1991, has been extracting salt and soda ash from concentrated brine. The brine reserves (estimated at 16Mm3) are found in the Sua Pan, which covers an area of 3500km2 in the northeast of the country. As a consequence of poor demand for soda ash and salt in southern Africa in the late nineties, the Sua Pan plant had been operating below capacity, producing 195,000t/y (full capacity 300,000t/y), and 214,000t/y (full capacity 650,000t/y) soda ash and salt respectively. However, since the turn of the century, production has been on the increase, reaching 282,000t (soda ash) and 260,000t (salt) respectively in 2005, Ministry of Minerals, Energy and Water Resources (2010).

The mining industry is estimated to provide employment for approximately 18,000 people, accounting for 3.4% of total formal sector employment. If indirect employment as well as employment in non-mining activities is taken into account, more people are employed. However, mining does not directly employ a significant proportion of people compared to its contribution to GDP because mining in Botswana is highly capital intensive. Mineral exploration and exploitation have attracted substantial foreign direct investment compared to other sectors of the economy, Modise (2000).

2.4.1.2 Financial Services Sector

The financial services sector is the largest service sector in value of export revenues after travel related and transport services and has established a good position regionally. Botswana's financial sector is growing at an increasing rate. The financial sector in Botswana is composed of three main sub-sectors: banking, insurance and pension; and capital markets (security). Prior to the 1980s Barclays Bank of Botswana and Standard Chartered Bank of Botswana dominated the banking sector. In 1990, the Bank of Botswana liberalized its licensing policy for new banks. At the moment there are eight commercial banks operating; mostly foreign owned. Botswana has several insurance companies which offer a full range of insurance products. Currently the insurance sector has 14 insurers (life and non-life insurers) many of which are wholly foreign owned (mainly South African) and three are joint ventures with local companies. In addition, there are 31 registered insurance brokerage firms (five with local ownership) and 126 corporate agents (a majority of which are foreign owned). Botswana Stock Exchange (BSE) was established in 1989 and it has grown over the

years and currently has 23 listed companies (16 local and seven foreign sector companies) and 44 traded securities, 19 of which are bonds. In addition to ordinary shares, three bonds are listed in the stock exchange. BSE is considered one of Africa's best performing stock exchanges with an average 24% aggregate return in the past decade. This has allowed the BSE to be the third largest stock exchange in Southern Africa, in terms of market capitalization. Due to Botswana's lack of exchange controls, stable currency and exceptionally performing stock market, the financial sector has attracted a host of global investors seeking better returns, Willem te Velde and Cali (2007). In light of the rapid development of the pension and insurance industries, a new supervisory authority, the Non-Bank Financial Institutions Regulatory Authority (NBFIRA), was created in mid-2008. The Non-Bank Financial Institutions Regulatory Authority (NBFIRA) is the agency responsible for the supervision of financial institutions other than banks, including insurance companies, pension fund operations, capital markets, and micro-lenders. As of September 30, 2011, the financial institutions under NBFIRA's supervision held P70.1 billion in financial assets, MFDP (2012).

2.4.1.3 Tourism Sector

Tourism as an economic sector was almost nonexistent at independence but with time, it has grown to become the second largest economic sector contributing 14% to GDP

in 2008. Its rapid growth has been described as the new engine of growth of which it will aid with the country's diversification endeavours, Mbaiwa (2002).

Botswana has one of the world's most unique ecosystems; the Okavango delta and it also offers excellent bird watching and gaming view both in the delta and in the Chobe Game Reserve which is a home to one of the largest herds of free ranging elephants in the world. It also hosts the well known Kalahari Desert in the south to the world famous Okavango delta and Chobe River plains to the north. The Government has set aside more than 17% of all available land for National Parks and wildlife sanctuaries and a further 22% as wildlife management areas. These resources are sought after by tourists globally and strongly compliment the global tourism trend towards greater environmental awareness and the need to experience nature in its original state, DoT (2008). During the 1998- 2002 period tourism arrivals grew from 794,544 to 1,036,558 at an average rate of 6.7% and in 2008 it was estimated that 1.5 million tourists had visited Botswana in that year alone.

2.4.1.4 Manufacturing

Botswana has a small, but dynamic, manufacturing sector, which contributed approximately 4% to GDP in 2008. Average growth in this sector during the 1990s was 3.8%, and it was seen in the early 2000s as having the most growth potential in the country. The sector has diversified into textiles, beverages, chemicals, metals, plastics, and electrical products. The government parastatal, the Botswana

Development Corporation (BDC)[4], has declined in significance relative to private initiatives, but still is a major promoter of industrial development with interests in brewing, sugar, furniture, clothing, tourism, milling, and concrete. Though the industry looks promising, industrial development is limited by a small domestic market, weak infrastructure, import dependence, and small skilled labour force.

2.4.1.5 Agriculture Sector

The agricultural sector used to be the mainstay of the economy before the discovery of diamonds. In 1966 agriculture's share to GDP was 42.7% and over the years it has withered to less than 5%, UN (2002). In the 2007/08 it contributed 3% to GDP. Despite the poor performance of the sector, agriculture is still providing the largest amount of livelihood for most Batswana. This is so because most of Batswana still live in rural parts of the country and hence dependent on crop production and livestock farming.

Agriculture is dominated by cattle rearing and subsistence farming. It is however, plagued by various factors like poor soil condition and erratic rainfall. This is one of the reasons that explain the poor performance of the sector. Some of the reasons for the decline of the agricultural contribution are; strong growth of the mining sector, associated growth in the public sector, failure to modernise the agricultural sector and

[4] Botswana Development Corporation Limited (BDC) was established in 1970 to be the country's main agency for commercial and industrial development. The Government of Botswana owns 100 percent of the issued share capital of the Corporation.

improve productivity, lack of agricultural investments; and lack of interest from the youth who prefer paid employment, SADC MAPP (2007).

Botswana's agriculture operates in a socioeconomic context that differs from most African countries. This has positive and negative impacts on the sector. It allows government to invest and support the sector; however, agriculture faces competition for labour and financial capital from other economic sectors.

According to the Botswana Agricultural Census Report (2008), Botswana has over 113,000 agricultural holdings, compared to 80,000 in 1980. The commercial agricultural sector is small, covering not more than five hundred mostly livestock farms. Most farmers operate in communal areas and are labelled the traditional sector. Many traditional farmers are subsistence oriented, but some, particularly at cattle posts, are semi-commercial. Crop farming in Botswana is heavily dependent on rainfall and as such, given the erratic rainfall and high temperatures coupled with the country's prone to droughts, the sub sector is highly unlikely to be seen booming like it is desired. The 2004 Agricultural Census indicates that total farmers with land decreased slightly by 1.1% from 64,090 in 1993 agriculture census to 63,357 suggesting that there has not been an improvement in the sub sector since the last census. Total land area decreased significantly by 30.0%, from 322,200 to 225,608 hectares with significant reduction in the traditional sector (32.7%) as compared to the increase in the commercial sector (38.6%). Farmers who actually planted (crop holdings) went down slightly by 0.8% with further decreases in total area planted (43.1%) and harvested (2.6%) in 2004. Although there were significant reductions of

crop holdings in the commercial sector (24.7%) when compared to the traditional sector (0.7%), area planted and harvested increased significantly by 93.4% and 93% respectively in the commercial sector as compared to decreases of the same in the traditional sector. Despite the decline in the traditional sector, production in the traditional sector for the four major crops (sorghum, maize, millet and beans/pulses) increased by 90.8% as compared to 9.2% for the same crops in the commercial sector. As shown in table 2.2, Cattle holdings[5] increased by 33.4%, from 54,349 to 72,521 at national level between 1993 and 2004 agricultural censuses. The cattle industry continues to show a fluctuating pattern partly because of the recurrence of disease out breaks such as Contagious Bovine Pleuro-Pneumonia (CBPP) and Foot and Mouth (FMD). The erratic rainfall patterns and high temperatures resulting in recurrence of droughts also compounded to the situation. These have a negative effect on the national herd. The 2004 Agricultural Census results indicate that cattle population increased by 18.3% nationally, from 1.8 million in 1993 to 2.2 million in 2004. The increase in the traditional sector herd could be attributed to the fact that farmers are gradually adopting new technology initiatives through the Ministry of Agriculture schemes and programs, with regard to improvement of cattle management and also the issue of commercializing agriculture, CSO (2008). On the other hand, goat population and sheep population decreased by -15.6% and -2.5% respectively.

Table 2.2: Cattle, goats and Sheep Holdings and Population between 1993 and 2004 Agricultural Censuses

[5] Holding is an economic unit of an agricultural production under single management such as total area and livestock by type owned, managed, rented or operated by a holder(farmer).

INDICATORS	1993 Agriculture Census	2004 Agriculture Census	%Change
Total Holdings	101,434	121,325	19.6%
Cattle: Total Holdings	54,349	72,521	33.4%
Cattle Population	1,820,700	2,154,820	18.3%
Goats: Total Holdings	79,189	78,765	-0.5%
Cattle Population	1,837,700	1,550,337	-15.6%
Sheep: Total Holdings	19,214	17,771	-7.5%
Cattle Population	250,100	243,902	-2.5%

Source: CSO (2008).

Despite the farming industry declining share of the GDP, it remains vitally important to the economy as it was identified as one of the key sectors that can aid diversification of the economy. In May 2008 the Agricultural Hub was established as a catalyst for the greater commercialisation and diversification of the sector, as well as to improve food security. Its aim is to develop an environment that will encourage, facilitate and support a viable and economically sustainable agricultural sector, by spearheading production of quality agricultural products for local, national and international markets, Ministry of Agriculture (2010).

2.2 Background of BMC

Botswana Meat Commission was established by an act of parliament and other livestock related laws, Mapitse (2008). It was established in the year of Botswana's independence in 1966. It serves as a sole exporter of meat and its by products and also sells directly to retailers in the local market. BMC is a non profit making enterprise

that is affiliated to the ministry of agriculture, Samatar and Oldfield (1995). It is furthermore statutorily obliged to distribute to livestock suppliers all surpluses over and above legally stipulated contingency reserves. The implication is that decreases in meat prices and increases in BMC costs must be passed onto suppliers in lower prices, unless they are temporary and can be smoothed out using the contingency fund, Hubbard and Morrison (1985).The BMC is a traditional type of marketing board that is a monopsony purchaser of cattle from ranchers. The BMC has been largely controlled by cattle interests and aided the development of the beef industry.

Botswana Meat Commission has three abattoirs two of which are operational. It currently operates two abattoirs in Lobatse (800 cattle/day capacity) and Francistown (350 cattle/day capacity) with a combined capacity to slaughter over 300,000 cattle per annum in current configuration (5 by 8 hour days and 48 hour chill cycles). The Lobatse abattoir was established in December 1966 and Francistown BMC was established in 1983, this was followed by the Maun abattoir in 1989 which was closed indefinitely in 1996 after the outbreak of Contagious Bovine Pleuropneumonia in Ngamiland where 330,000 cattle were destroyed as a disease eradication measure, Mapitse (2008). BMC since its inception has expanded the capacity of its facilities so as to take advantage of its growing market. The advantage of having such high grade abattoirs means that all producers are assured of a safe and reliable market as well as a stable price for their animals, Samatar and Oldfield (1995).

Botswana Meat Commission has subsidiaries and associated companies locally, in Europe and in South Africa. The subsidiaries play a pivotal role of being an integral

part of the BMC export chain through providing cold storage and logistical services, BMC (2008).

2.2.1 Performance of BMC

Botswana has had a privilege of free access to the lucrative and protected European Union market because of the Cotonou Agreement which expired in 2007. The BMC's success in sustaining the health of the industry in increasingly tough markets to access has depended on its ability to manage properly its domestic production operation, Stevens and Kennan (2005). The most attractive market for Botswana beef is in the European Union, where Botswana has large trade preferences. She can also export into the USA at duty free and quota free but tariff preference is only between 0% and 4% making exportation to the EU market to be at a significantly lower tariff than most countries. December 31st 2007 marked the expiry of the Cotonou Agreement which Botswana beef has been using to access the EU market. An interim EPA was initialled which gives Botswana duty free and quota free market access into the EU, leaving Botswana beef to still have a huge trade preference into the European Market, BEDIA (2008).

BMC has EU markets mainly in Denmark, Holland, Belgium, United Kingdom, Germany, Italy and Greece including the territories of the European Communities such as Reunion. Other markets include Norway, Hong Kong, Kenya, Malawi, Zimbabwe, Mauritius and South Africa. Botswana is also increasingly becoming a significant market for BMC products, Stevens and Kennan (2005).

Given its privileged position one would assume that supply of cattle at abattoirs would rise significantly and be consistent with the privileged opportunities. Unfortunately performance of BMC over the years has been marked with fluctuations and as a result BMC has not been able to satisfy its EU beef quota of 18,961 tonnes before it expired in 2007, BEDIA (2008). Table 2.3 shows fluctuations in performance in terms of throughput from BMC abattoirs and net sales derived.

Table 2.3 Cattle Throughput and Net Sales of BMC, 1966-94

Year	Throughput SA Rand (Million)	Net Sales
1966	132,232	6,895

1967	88,535	11,120
1968	103,776	10,593
1969	93,074	9,334
1970	127,317	11,915
1971	167,180	14,962
1972	156,510	19,547
1973	209,443	31,297
1974	186,041	34,711
1975	88,440	33,889
1976	212,000	44,814
1977	197,000	42,042
1978	149,000	31,327
1979	228,961	75,893
1980	140,783	39,847
1981	202,001	71,186
1982	237,135	87,549
1983	233,900	96,286
1984	239,293	96,745
1985	189,207	73,220
1986	193,843	128,535
1987	126,886	120,288
1988	112,498	95,380
1989	134,558	146,789
1990	146,729	159,791
1991	182,550	161,302
1992	188,264	212,858
1993	164,351	172,987
1994	171,737	222,279

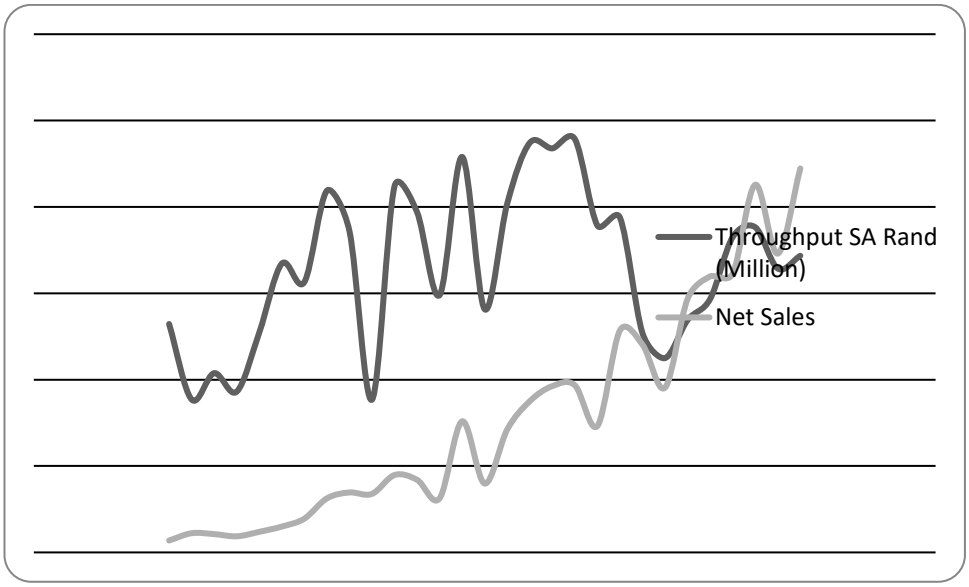
Source: Samatar and Oldfield (1995).

Table 2.3 shows throughput and net sales for the period 1966-94, as shown in the table throughput and net sales fluctuates almost every other year. The longest peak

experienced which was five years ranged from 1988 to 1992. It is noteworthy to point out that in other years where throughput increased it was not accompanied by a rise in net sales for instance in the period 1967-1968.

Figure 2 shows that on average net sales have been rising and throughput has been on the decline.

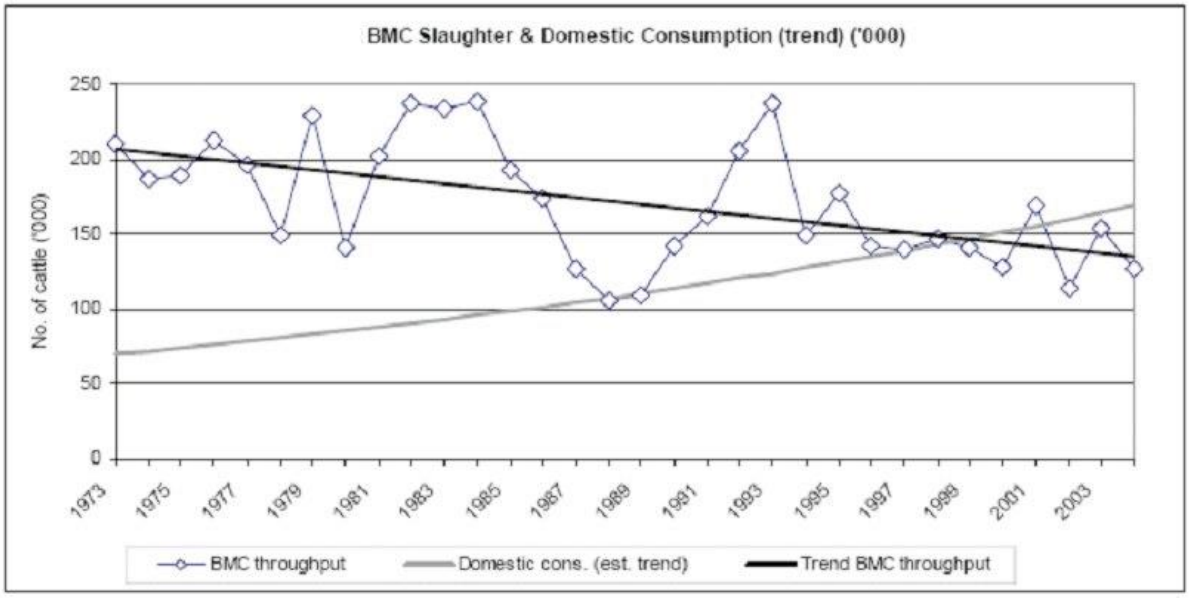
Figure 2: Cattle Throughput and Net Sales of BMC, 1966-94 Graph



Source: Author's Estimation

The number of cattle supplied to the BMC has declined in recent years whilst domestic consumption has increased and local butcheries have attracted an increasing number of cattle made available for slaughter because of price differentials as shown in Figure 2.1. As a result, throughput at the BMC abattoirs has declined leading to excess capacity and high cost of production, which has in turn led to a low price offered to the farmer. Since BMC is the price setter, the average price offered to the farmer has declined over the years leading to a crisis in the cattle sector.

Figure 2.1: BMC Slaughter and Domestic Consumption Trend



Source: BEDIA (2008)

According to Stevens and Kennan (2005), there are possible factors to help explain poor performance of the beef sector. One possible explanation for the current problems of the beef sector is that prices in BMC's export markets have not risen, at least in non-Pula terms. There is poor diversity of both BMC's products and its markets, but chilled and frozen beef to the EU remains the most significant combination. In 1989/90 boneless chilled and frozen beef accounted for 80% of sales; in 2003 it was still 77%. In the same two years the share of exports destined for the EU was 69% and 57% respectively.

Another possible reason is that the costs of storage and shipment outside Botswana has increased and it is has translated into poor prices offered by the commission which has led to farmers finding alternative markets for their cattle. The fall in throughput has

had an effect in raising per unit production costs. But this is not the only source of rising costs. The increasing demands of the EU's SPS regulations are also important. A part of the reason for BMC's failure to operate at full capacity has been the closures required from time to time to deal with animal disease outbreaks, most notably the FMD outbreaks that closed the Lobatse and Francistown abattoirs for months in 2002-03. In addition, though, the cost of complying with the EU's SPS regulations has increased much of it is borne by the government. BMC (2008) states that FMD outbreaks in the country are of concern as the Ngamiland outbreaks have been going on for far too long without resolution. Fresh outbreaks continue to be reported in cattle that have been vaccinated over and over again.

2.2.2 Policy Responses to Poor Performance

Due to BMC's poor performance over the years, the government has been forced to intervene greatly. BMC is a heavily subsidised parastatal and government continues to bear most of the costs associated with SPS regulations and investment activities meant to improve the performance of the commission. The costs borne by the government are more compared to taxes received by the government from commission, BEDIA (2006). It has been suggested that the rationale for the Government's generosity may be explained by its determination to keep as many people as possible in the rural areas, and to help them earn an income from their livestock in the absence of industrial and services employment in the urban centres, Samatar and Oldfield (1995).

BMC has also introduced new initiatives aimed at increasing throughput at its abattoirs. BMC Producer handbook (2008/9) states that one of the reasons for poor

performance is the poor quality of the cattle supplied to them due to poor animal welfare and bruises from poor transport conditions. Faced with performance issues, BMC has over the years initiated massive changes so as to deal with emerging issues which had an effect on production and performance. Initiatives include changes in the pricing structure with the introduction of Export Parity Pricing (EPP).

According to BMC (2008/09), EPP is based on the regional price from weekly information obtained from the Red Meat Abattoir Association in RSA. This price information is collected across RSA and then an average price is worked out. Adjustments are made and the Pula exchange rate is applied to give weekly BMC base price. The EPP prices are only paid for carcasses above 180kg CDM. Carcasses below 180kg are not paid EPP because they do not meet the export markets requirements and therefore are sold into lower value markets which give BMC a lower return.

Another initiative that was introduced is the Premium Payment Scheme. This scheme was introduced so as to stimulate throughput of right quality in order to take advantage of at the time current high prices BMC, (2008/09). This premium payment is P200/kg CDM for qualifying animals. Other schemes that have been put in place to improve throughput are Cattle Feed Advance Scheme, BMC Cattle Collection Scheme and Large Scale Feedlot Advance Scheme.

The purpose of cattle feed advance scheme is to increase the supply of cattle to BMC abattoir, improve quality of cattle supplied and improve reliability of cattle supply. Conditions of the scheme are that, producers enter into a cattle feeding contract with

BMC to fatten their cattle. In turn a producer is given an advance of P 1,600 per head but the advance is in the form of BMC paying for the feed directly to the supplier and no cash advances. The producer is responsible for transporting the feed from the supplier to the feeding point and no cattle will be removed from the feedlot without prior BMC permission. In the end the advanced money plus a preferential rate of interest will be recovered from the proceeds of cattle after they are slaughtered at the BMC abattoirs. BMC cattle collection scheme purpose is to increase transport to the abattoirs by reaching out to the producers who will otherwise not be able to supply due to logistical problems associated with selling cattle.

As an attempt to increase off take and develop the national herd in the right direction, feedlot production has been identified as the production system of choice to deliver the required change. The feedlot production is expected to re-direct the industry toward supplying the 230,000 head of cattle needed to run both abattoirs at capacity and satisfy the increasing demand internationally for our great product, BEDIA (2008). Large scale feedlot advance scheme purpose is to increase the supply of cattle to BMC abattoirs and improves quality and reliability of cattle supplied. This scheme is similar to the cattle feed advance scheme but it is mainly targeted to feedlotters to provide services to BMC by providing feeding schemes to producers. The scheme provides terms and conditions that feedlotters should adhere to and benefits of participation.

2.3 Conclusion

The chapter reviewed the evolution of Botswana economy and its key sectors. It also highlighted background information and performance of Botswana Meat Commission. The next chapter provides theoretical and empirical literature on efficiency.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

This chapter gives a brief explanation of theoretical background and theoretical tools used to explain efficiency. Also empirical findings surrounding efficiency and factors influencing efficiency are highlighted.

3.1 Theoretical Literature Review

According to microeconomic theory the objective of the firm is to maximise output given inputs with minimum costs. Efficiency of a firm means its ability to produce as much as possible an output from a given sets of inputs alternatively it is comparison of the observed to the maximum obtainable output from given inputs (Farell, 1957, Lovell, 1993). Overall efficiency of the firm is equal to the product of the technical and price efficiencies and also has to take into consideration quasi factors. The theory of production forms a foundation for evaluation of efficiency. Production is the maximum amount of output that can be produced from a given stock of inputs. The level of production is determined by the level of technology a firms has and inputs available. Firms can either operate inside or along the production possibility frontier.

According to Mas-Colell *et al*. (1995) a production vector is efficient if there is no other feasible production vector that generates as much output say using Y no additional inputs, and that actually produces more of some output or uses less of some input.

3.1.1 Production Possibility Frontier (PPF) and Efficiency

The PPF shows the most efficient allocation of resources that is, it shows the maximal combinations of two goods that can be produced during a specific time period given fixed resources and technology and making full efficiency use of available factor resources. The PPF is concave to the origin because the extra output resulting from allocating more resources to one particular good may fall alternatively also known as

law of diminishing returns. The PPF will shift due to improvements in productivity and efficiency and more factor resources being exploited.

3.1.2 Generalized Measures of Efficiency

Three types of efficiency were introduced in a seminal paper by Farrell (1957). These were technical efficiency, price or allocative efficiency, and overall or x-efficiency. Farrell assumed that one single production function with constant returns to scale represented the entire frontier production function. Under the assumption of constant returns to scale, transformed isoquants collapse into a single curve in the input-coefficient space.

3.1.2.1 Technical Efficiency

Production is considered technically efficient if the combination of inputs yield the highest possible level of outputs. A producer is technically efficient if, and only if, it is impossible to produce more of any output without producing less of some other output or using more of some input.

Technical efficiency is measured as:

$$\text{TE}= \frac{Y_i}{Y_i^*}$$

Where TE is technical efficiency, Y_i is the actual output and Y_i^* is the maximum attainable output. TE ranges from o to 1, a ratio of 1 implies that a firm is technically

efficient and production lies on the frontier while any ratio of less than 1 show that the firm is inefficient.

3.1.2.2 Allocative Efficiency

Allocative or price efficiency, refers to the ability of a firm to choose the optimal combination of inputs given input prices. Allocative efficiency is concerned with passing value judgement about the combination of inputs which is based on some objective function. Under the assumption of firms facing same factor prices, a measure of allocative efficiency, or price efficiency, is based on comparing observed average cost with the average cost. Allocative inefficiency reflects deviations from the minimum cost input ratios.

Allocative efficiency is measured as:

$$\frac{Mpx_i}{Mpx_1} = K_i \frac{W_i}{W_1} e^{ui} \qquad i = 1,2,\ldots,n$$

Where Mpx_i are marginal products of x_i; K_i are factors of proportionality and are firm and input specific; ui are random errors; and W_i are input prices.

3.1.2.3 X-Efficiency

X-efficiency is a concept that was originated by Harvey Leibenstein (1966), applied to management efficiencies. X-efficiency occurs when the output of firms, from a given amount of input, is the greatest it can be, in other words defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology. It is likely to arise when firms operate in highly competitive markets where managers are motivated to produce as much as possible. Contrary, the failure of firms to produce on the efficient frontier is by and large motivated by

following set of reasons including inadequate motivation, incomplete contracts, asymmetric information, agency problems and attendant monitoring difficulties which are lumped together and form X-inefficiency.

3.1.3 The Efficiency Frontier

Efficiency measures are often based on unit requirements of inputs. Under this case, the production functions may be transformed from the factor space into a space of input coefficients. The input coefficient space is denoted as:

$$\xi = \xi_1, \xi_2, ..., \xi_n$$

where ξ is an input coefficient defined as;

$$\xi_i = \frac{x_i}{Y} \qquad i = 1, ..., n$$

The standard production function or input output transformation function can be written as;

$$Y^j = f^j\left(\frac{x}{Y^j}\ Y^j\right) = f^j(\xi^j Y^j)$$

where Y^j is output of firm j, X is input and ξ is input coefficient. The input output transformation forms a set of feasible input coefficients bounded towards the origin and the coordinate axes of the factor space under certain restrictions on the production functions. Since the input coefficients are the inverse of average productivities, the transformed optimal scale curve must be the boundary towards the

origin and axes of the set of feasible input coefficients. The optimal scale surface is transformed into the input-coefficient space by inserting above relation 1 into;

$$\Phi(x_1,...x_n) = 1$$

The optimal scale surface transformed to the input-coefficient space is called the efficiency frontiers.

According to Le and Harvie (2010) a number of techniques have been developed to estimate efficiency are broadly classified parametric and non parametric. The parametric method uses an econometric technique by specifying a stochastic production function which assumes that the error term is composed of two elements. One is the statistical noise representing randomness and the other represents technical efficiency assumed to follow a one sided distribution.

On the other hand, the non parametric approach does not distinguish between technical efficiency and statistical noise. The non parametric approach is often associated with Data Envelopment Analysis (DEA) which is based on a mathematical programming model to estimate the optimal level of output conditional on the amount and mix of inputs, Murillo-Zamorano (2004).

3.1.4 Stochastic Production Frontier

The stochastic production frontier can be written as

$$Y = f(X_i\beta) + \varepsilon$$

where *Y* is output , *Xi* is inputs and β is a vector of unknown parameters. The essential idea behind the stochastic frontier model is that ε is a "composed" error term (Aigner,

Lovell, and Schmidt, 1977; Meeusen and Van den Broeck, 1977). This term can be written as:

$$\varepsilon = v - u$$

where v is a two-sided ($-\infty < v < \infty$) normally distributed random error ($V\ N\ (0, \sigma_v^2)$ that captures the stochastic effects outside the firms' control, measurement errors, and other statistical noise. The term u is a one-sided ($u \geq 0$) efficiency component that captures the technical inefficiency of the firm which can be measured as the deficiency in output away from the maximum possible output given by the stochastic production frontier. In other words, u measures the shortfall in output Y from its maximum value given by the stochastic frontier $f(Xi; \beta) + v$. This one-sided term can follow such distributions as half-normal, exponential, and gamma (Aigner, Lovell, and Schmidt, 1977; Greene 1980; Meeusen and Van den Broeck, 1977).

3.1.5 Data Envelopment Analysis

DEA assigns a score of 1to a unit only when comparisons with other relevant units do not provide evidence of inefficiency in use of any input or output. DEA assigns an efficiency score less than one to inefficient units. The score reflects the radical distance from the estimated production frontier to the decision making units (DMU) considered. The DEA ratio which is converted to linear programming model is given as:

Max $ho = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=i}^{m} v_i x_{io}}$ Subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=i}^{m} v_i x_{ij}} \leq 1;\ j = 1, 2, \ldots, n$$

$$\frac{u_r}{\sum_{i=1}^{m} v_i x_{io}} < \varepsilon; r = 1, 2, \ldots, s \text{ and}$$

$$\frac{v_i}{\sum_{i=1}^{m} v_i x_{io}} < \varepsilon; i = 1, 2, \ldots, m, \quad \varepsilon > 0$$

where the number of decision making units (DMUs) range from $j = 1, 2, \ldots, n;\ y_{rj} > 0$ and x_{ij} represent the observed quantities of rth outputs and ith inputs of jth DMU. The efficiency score of DMU_0 is $0 \leq h_0 \geq 1$ with respect to the constraints. $\varepsilon > 0$ is a constant that is smaller than all positive valued real number for $h_{0;}$ u_r and v_i represents visual multipliers from the maximization problem. In equation 2 the numerator and denominator represent a set of desired outputs and inputs respectively. Observed output, $Y_0 = \sum u_i^* y_{ro}$ is summed from r = 1, 2, …, s; observed input, $X_0 = \sum v_i^* y_{io}$ is summed from i = 1, 2, …, m. From this, we obtain the efficiency score, $h_0^* = \frac{Y_0}{X_0}$ which satisfies $0 \leq h_0^* \geq 1$. The ratio of $h_0^* = 1$ represents full efficiency, and the ratio of h_0^* < 1 represent some nature of relative inefficiency. Asterisk in the model represents optimal level.

3.1.6 Synthesis of Theoretical Literature

The production theory is relevant to this study as it provided the foundation for evaluating efficiency. The theories also helped in establishing different forms of efficiency and econometric tools to measure them. From the different forms, technical efficiency was adopted in this study. The parametric method which uses an econometric technique by specifying a stochastic production which assumes that the error term is composed of two elements: statistical noise and technical efficiency was adopted as it was relevant to the study. It considers both factors beyond the control of the firm and specific factors, hence close to reality, Le and Harvie (2010). The method was chosen because it includes the statistical noise into the frontier and allows for statistical tests on estimates unlike the Data envelopment analysis which does not allow that.

3.2 Empirical Literature

A study by Aung (2011) evaluating agricultural efficiency of rice farmers in Myanmar using a Cobb-Douglas production frontier function found that, the mean level of profit efficiency is relatively high but there was a significant variation between efficiency indexes among farms. Farmers who had high income from secondary crop tended to lower profit efficiency. The higher educational level of farmers reduced the profit inefficiency. Farmers who had higher schooling year had more allocative ability in

relation to perceiving and responding to the changes in the market price and market behaviour.

In the investigation of technical efficiency of agriculture in Ghana with the use of time series data and stochastic frontier model it was established that technical efficiency has a mean of 82%, minimum of 59% and maximum of 96%. It was also established that capital variables were output inelastic and labour was elastic to output with elasticity of 1.28. The sum of elasticities equalled 1.74 indicative of increasing return to Ghana's agriculture over the 1961-2010 period, Djokoto (2011).

Miljkovic and Shaik (2010) employed a stochastic frontier model in assessing the impact of trade openness on technical efficiency in United States agriculture and found out that trade openness had no influence on technical efficiency. A positive relationship was established between technical change and time. A change from one year to the next would lead to a 0.02% increase in the output index. The only factor input with significant impact on the productivity was labour, a 10% increase in the use of labour would lead a 2.33% increase in the output quantity index.

According to Le and Harvie (2010) using stochastic frontier production function to evaluate technical efficiency performance of Vietnamese manufacturing small and medium enterprises over the period 2002-2007 found out that, Vietnamese non manufacturing SMEs operated on a high level of technical efficiency, both in the manufacturing sector in aggregate and in terms of sub-sectors. The sub-sector analysis showed that technical efficiency ranged from 70 percent to 100 percent - or full

technical efficiency, across sub-sectors in the 2002 – 2007 period. It was found that the high-tech Electronics and Electrical Equipment subsector had the lowest mean technical efficiency level of around 80 percent for the three surveys. The low-tech Wood and Furniture sub-sector consistently performed with full technical efficiency.

Aggrey *et al*. (2010) when assessing the relationship between firm size and technical efficiency in East African manufacturing firms, results showed a negative relationship between the firm size and technical efficiency contrary to expectation, suggesting an inverted u-relationship between the firm and technical efficiency. Additionally, foreign ownership was shown to be positively related to technical efficiency in Kenyan manufacturing firms.

According to Macedo and Silva (2010) with the use of stochastic production frontier for analysis in the investigation of technical efficiency of wine producers in Portugal, found that, all production units are technically inefficient but wine cooperatives are less inefficient than private firms.

In a study to identify determinants of firm profitability by Stierwald, (2009) with the use of random and fixed effect regression, it was identified that lagged profit rates, lagged productivity level and persistence of high productivity have a positive large impact on firm profitability. The more profitable and productive firms were in the past, the higher their current profit.

Otieno *et al.* (2008) using a single equation model found that determinants of beef export supply were domestic production, livestock development expenditure as a ratio

of GDP, operation of the Kenya Meat Commission and occurrence of Foot and Mouth disease (FMD) and Rift Valley Fever. Domestic beef production and operation of the KMC were significant in increasing Kenya's beef export supply, while occurrence of notifiable diseases derailed the country's capacity to competitively participate in beef export trade. In addition, increased share of livestock development expenditure to GDP contributed to increased beef export supply. However, privatization of Artificial Insemination services had no significant influence on beef export supply.

Ray (2006) in evaluating the changing role of technological factors in explaining efficiency in Indian firms using stochastic production frontier found that, the variables relating to external competition and technology flow from outside such as royalty payments, exports and import of raw materials became significant in the year 2001 which were not so in the year 1991. The conclusions emerging from the study suggests that the factors relating to technology and international orientation became significant in explaining inefficiency in the year 2001 compared to the year 1991. Exposure to foreign technologies has helped to improve the efficiency of firms.

Lopez *et al*. (2006) using stochastic production and distance frontiers to measure technical efficiency for Argentinean dairy farms, found that average technical efficiency across models ranged from 67.2% to 88.4%. The analysis also revealed a significant rate of technological regress.

Somwara and Valdes (2004) with the use of data envelopment analysis for analysis to investigate Brazil beef production and its efficiency found that the most integrated operations were most efficient with increasing returns to scale economies. The overall

efficiency estimate for all 450 operations was 0.945 indicating low overall efficiency. However the estimated scale elasticity indicated increasing returns of all types of cattle production.

With the use of stochastic frontier analysis to assess the efficiency in the manufacturing industry in Turkey, Onder et al (2003) found that for the whole manufacturing industry, there was a decline in the technical efficiency, but an improvement in technology, which, together, led TFP change to fluctuate around a certain level. The study also found out that large scale enterprises were more efficient and also private manufacturing industries were more efficient than public industries. Findings suggested that the provinces in which technical efficiency levels of the manufacturing industry were above the sample mean were generally metropolitans, or in the hinterland of these metropolitans. This implies that manufacturing industries reap the benefit of urbanization effects and metropolitan externalities, that is, infrastructure, technology, information network, availability of qualified labour, and so forth, in these regions.

Chen *et al.* (2003) when investigating technical efficiency of Chinese grain production using the stochastic production frontier approach found that marginal products of labour and fertilizer are much smaller than that of land, human capital and farm level specialization have positive effect on efficiency, land fragmentation is detrimental to efficiency and elder farmers are as efficient as younger farmers.

Pitt and Lee (1981) using stochastic production functions found out that the Indonesian weaving industry was relatively efficient with mean efficiency for the Indonesian weaving industry of between 60 and 70 percent and also found that sources of efficiency can be explained by three firm characteristics; age, size and ownership.

3.2.1 Synthesis of Empirical Literature Review

In consideration of variables used in a study by Pitt and Lee (1981), the selection of variables took care of the possibility of bias in the results obtained. In consideration of the variable ownership of firm, the study considered the incentives packages availed to both domestic and foreign investment, after the realisation that both the domestic and foreign firms have equal opportunities in terms of profit tax holiday, loss carry over, customs duty, exemption for imported capital equipment and accelerated depreciation, ownership was taken up as one of the possible factors of efficiency.

On the other hand Aggrey *et al*. (2010) did a comparison study for East African manufacturing but in the choice of variables it was assumed that the countries are similar in respect to the business climate and challenges. Due to the omitted differences there exists bias in the results reported. A similar assumption was assumed in the study by Macedo and Silva (2010), in the comparison study of firms, it was assumed that firms were the same irrespective of public infrastructure investment and regional disparities hence existence of bias. The same limitation is observed in Chen *et al.* (2003) study.

Another limitation observed in the reviewed studies is omission of important variables. Djokoto (2011) omitted rainfall and farm tools as explanatory variables in the investigation of efficiency in agriculture in Ghana. Omission of these variables though dominant in production, results in loss of important data that could help in understanding the agricultural sector.

On a positive note, Lopez *et al*. (2006) used both stochastic production and distance frontier in order to take care of the limitation of the production frontier of allowing only a single output, by doing so it produces close to reality results.

Empirical literature reviewed is mainly cross section and panel data based hence comparison studies. The downfall of comparison studies is that critical information regarding uniqueness of individual firms is ignored hence analysis disregard heterogeneity which might better explain performance of the firm. This study will investigate a single firm in order to capture individual traits of the firm that will better explain its efficiency. The empirics helped with variables that are believed to influence efficiency. Adoption of profit, foot and mouth disease, age and external forces in explaining efficiency were guided by empirical literature.

3.3 Conclusion

The chapter presented both the theoretical and empirical literature. The theoretical literature highlighted the production theory as a basis for evaluation of efficiency and also presented techniques used for measuring efficiency. Empirical Studies that have

been reviewed indicate that there are a wide variety of factors affecting efficiency of firms. Some of the factors that were indentified to have influence on efficiency are age, size, ownership, technology flow and external competition. Foreign and private ownership have been identified to be positively related to efficiency. In addition large scale enterprises were found to be more efficient, foreign technologies and external competition also had an influence in improving efficiency of firms. Lastly it was also identified that older farmers are as efficient as young farmers. The following chapter is the methodology which highlights the estimation technique, data sources and measurement of variables.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

This chapter presents the methodology which is employed to assess issues of this study. Sources of data, definition of variables are also briefly discussed.

4.1 Efficiency Estimation Techniques

According to Le and Harvie (2010) a number of techniques have been developed to estimate the efficiency frontier and are broadly classified into two groups parametric and non parametric. The parametric method uses an econometric technique by specifying a stochastic production function which assumes that the error term is composed of two elements. One is the statistical noise representing randomness and the other representing technical efficiency assumed to follow a one- sided distribution. On the other hand, the non parametric approach does not distinguish between technical efficiency and statistical noise. The non parametric approach is often associated with Data Envelopment Analysis (DEA) which is based on a mathematical programming model to estimate the optimal level of output conditional on the amount and mix of inputs, Murillo-Zamorano (2004).

This study used the stochastic frontier analysis because fits more to the real situation under this study compared to Data Envelopment Analysis. The parametric method uses an econometric technique by specifying a stochastic production which assumes that the error term is composed of two elements: statistical noise and technical efficiency hence relevant to the study. The method was chosen because it includes the statistical noise into the frontier and allows for statistical tests on estimates unlike the Data envelopment analysis which does not allow that.

4.1.2 Stochastic Frontier Production

Le and Harvie (2010) assert that the stochastic frontier production model was developed independently and simultaneously by Aigner, Lovell and Schmidt (ALS) (1977), Meeusen and Van den Broeck (MB) (1977), and Battese and Corra (1977). In

this model there is a composed error term which captures the effects of exogenous shocks beyond the control of the analysed units in addition to incorporating technical inefficiency. Errors in measurement of outputs and observations are also taken into consideration in this model (Kumbhakar and Lovell, 2003; Murillo-Zamorano, 2004). The generalised functional form in the Cobb-Douglas case of the stochastic production function can be specified as:

$$Y_i = X_i\beta + (V_i + U_i), i = 1, \dots, N$$

where, Y_i is the output (or logarithm of production) of the ith firm; X_i is the vector of inputs of the ith firm; β is the vector to be estimated; V_i represent the random variable which is assumed to be independently and identically distributed (iid); U_i represent the random variable which is assumed to account for technical inefficiency in production and usually assumed to be iid.

The maximum likelihood method was used to estimate the coefficients of the production function. The likelihood function is expressed in terms of the variance parameters of the frontier function:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \; and \; \gamma = \frac{\sigma_u^2}{\sigma^2}$$

Where, σ_v^2 is variance of noise and σ_u^2 is variance of inefficiency effects.

If the value of σ^2 is equal to zero, then $U_i$is also zero which means the firms are fully efficient. γ has a value between zero and one. If the value of γ is zero, the deviations from the frontier are attributed to random error. If it has the value of one, the deviations are due to technical inefficiency.

The Translog stochastic production function is be expressed as follows:

$$\ln Y = \beta_0 + \beta_1 \ln L + \beta_2 \ln K + \beta_3 \ln ME$$

where: Y is Output of the firm; L is labour input; K is capital investment; ME is material input. The equation comprises also of the random error term V assumed to be $N(\mu_i, \sigma^2{}_v)$; and U which represents the technical inefficiency and is assumed to be $N(\mu_i, \sigma^2 u)$. The β's are coefficients.

4.2 Estimation of Determinants of Efficiency

In order to find factors influencing inefficiency an Ordered Logit model was employed. Efficiency was categorised into low, medium and high levels so as to determine if the explanatory variables had the same impact on all levels of efficiency. Logit, Probit and Tobit offer relatively similar results but Logit has a comparative advantage on the basis of mathematical simplicity, Gujarati (2003). Fox (2010) also emphases on the issue of simplicity of the Logit model; the equation of the logistic CDF is very simple, while the normal CDF involves an unevaluated integral. Another advantage of Logit model is the interpretability; the inverse linearizing transformation for the Logit model $\wedge^{-1}(\pi)$, is directly interpretable as a log-odds, while the inverse transformation $\phi^{-1}(\pi)$, does not have a direct interpretation. Logit model has also been employed by Girardone *et a.l* (1996) and Ray (2006) in past empirical studies.

The general Ordered Logit model is given as

$$y^* = x'\beta + \varepsilon$$

$$\begin{cases} 0 \; if \; y^* \; \leq \mu_1, \\ 1 \; if \; \mu_1 \; < y^* \; \leq \mu_2, \\ 2 \; if \; \mu_2 \; < y^* \; \leq \mu_3 \end{cases}$$

Where y^* is the latent variable which is unobservable and x is a vector of independent variables while β is a vector of regression coefficients to be estimated.

The Ordered Logit Model specified to estimate the determinants of inefficiency is given by:

Pr(*eff* =1|y^*) =*f* (L, K, FMD, π, Exc£, ExcR, I, Inf, P, MI, Age)

where: Pr(*eff* =1) is the efficiency while L represents labour, K denotes capital and FMD represents Foot and Mouth Disease. π denotes profit and Exc£, ExcR denotes the exchange rate of Pula to Pound and Rand respectively. I is inventory and Inf is domestic inflation rate. Lastly P represents price offered by BMC to producers, MI is material input and Age is the number of years the commission has been operation.

The efficiency scores are measured by:

$$TE = \exp(-u_t)$$

4.3 Data Variables

Labour is defined in monetary terms (Pula), it comprises of staff costs which incorporates wages and salaries and social security costs.

Capital is defined in monetary value (Pula) and comprises of property, plant and equipment employed in the production process.

Material Input is measured in terms of costs in Pula of average material input used in the production process. The costs considered are those incurred in livestock and meat purchases by the commission.

Foot and Mouth Disease is defined in terms of a dummy variable. It will take on values of 1 or 0, 1 indicating the presence of Foot and Mouth and 0 indicating the absence of the disease.

Profit is defined in monetary value (Pula) and is the net returns of the firm after taxation.

Inventory is defined in terms of total monetary value (Pula) of inventories.

Exchange rate is defined as the price of one currency in terms of the other. The exchange rate considered will be the Pula/Pound and Pula/Rand because a large proportion of the output goes to United Kingdom and South Africa.

Inflation rate it is the rate of change of the price level measured as a percentage change in consumer price index. Inflation rate is considered because the domestic market accounts for the second largest market of the commission's output.

Price is defined in terms of monetary terms offered to producers by BMC per 100 kilograms.

Age is the number of years that the commission has been in operation.

4.4 Hypothesis

The null hypothesis is that BMC is not technically efficient and the alternative hypothesis is BMC is technically efficient.

4.5 Data

The study analyses technical efficiency of Botswana Meat Commission and it is at micro level. There was no sampling involved as only one institution was considered and it is has the sole responsibility for beef and beef products exportation. The study used data on throughput, capital, labour, profit, exchange rate, inventory, inflation, price and foot and mouth disease for the period 1979-2009. The period was selected because of the availability and reliability of data.

4.6 Data Collection Instruments

The study employed secondary data. Secondary data on throughput, capital, labour, profits, exchange rate, inventory, inflation, price and foot and mouth disease for the period 1979-2009. The sources of data for exchange rate and inflation are Bank of Botswana and Central Statistics Office. Sources of data for throughput, capital, labour, profits, price and inventory is BMC annual reports. Data on incidence of foot and mouth disease was sourced from the Ministry of Agriculture.

4.7 Data Analysis

The study used stochastic frontier analysis for estimation of efficiency and Ordered Logit model for determinants of efficiency. Since all data are time series, it was tested for autocorrelation and heteroskedasticity after estimation to check for validity of estimated results.

4.8 Conclusion

The chapter highlighted the econometric tools used in analysis and the following chapter, chapter five presents the econometric estimation and analyses of results.

CHAPTER FIVE

ECONOMETRIC ESTIMATION AND ANALYSES OF RESULTS

5.0 Introduction

This chapter presents the descriptive, summary statistics and empirical results of efficiency and determinants of efficiency of Botswana Meat Commission. The summary statistics looks at the mean, standard deviation and minimum and maximum values. The descriptive statistics focuses on labour, capital, material input and output; variables which help explain efficiency.

5.1 Summary Statistics

Table 5.1 presents the summary statistics; it shows the distributional nature of the variables used in this study.

Table 5.1 Summary of Descriptive Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
Inflation	10.13548	2.528181	6.5	16.3
Pula/Rand	1.257948	0.1496531	0.998	1.654
Pula/GbP	0.2738903	0.1770075	0.0804	0.602
Fmd	0.2580645	0.4448027	0	1
Inventories	35015.19	29382.81	1334	147263
Profit	14952.58	27557.86	-70222	92525
Price	803.9516	463.4209	169.02	1849
Age	28	9.092121	13	43

Source: Author's Estimation

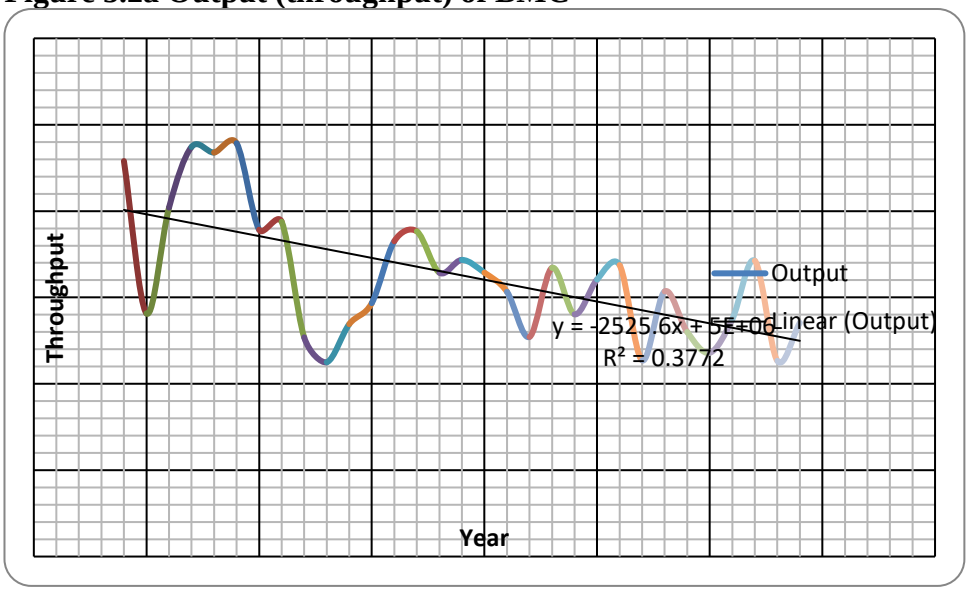
The summary statistics shows that the minimun value for inflation was 6.5 and maximum was 16.3. the mean value for inflation was 10.1 and the standard deviation was 2.53. Pula/Rand exchange rate had a mean value of 1.26 and a standard deviation of .15. Its maximum and minimum value was 1.65 and .998 respectively. The maximum value for Pula/Pound sterling exchange rate was .602 and the minimum value was .804. Furthermore, the mean value was .274 and the standard deviation was .178. Foot and mouth disease is a dummy variable with a maximum value of 1 and a minimum of 0. The standard deviation was .445 and the mean was .258. 1334 and 147,263 were the minimum and maximum vaues for inventories respectively. The mean value was 35015.19 and a standard deviation of 29382.81. Profit has a standard deviation of

27557.86 and a mean value of 14952.58. -70222 and 92525 were the minimum and maximum values respectively for profit.

5.2 Descriptive Statistics

This provides a trend analysis of the independent variables namely labour, capital and material input and the dependent variable output; variables used in the estimation of efficiency model.

Figure 5.2a Output (throughput) of BMC

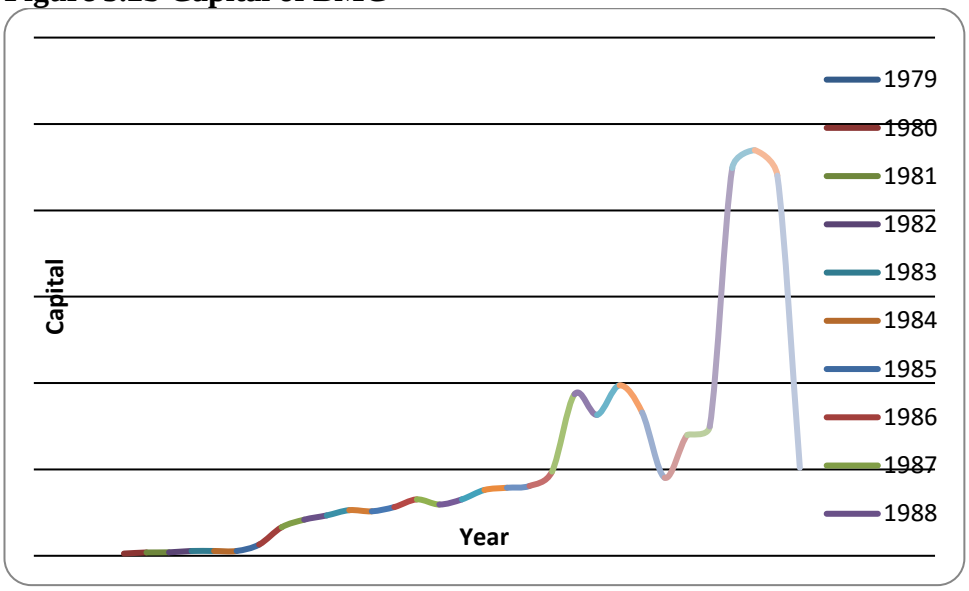


Source: Author's Estimation

The graph shows the trend of output. It shows that the output over the years has been flactuating. The highest output which is 239,293 was recorded in the early 1980's and

the minimum was recorded in the late 1980's. The graph shows a declining trend of throughput over the years.

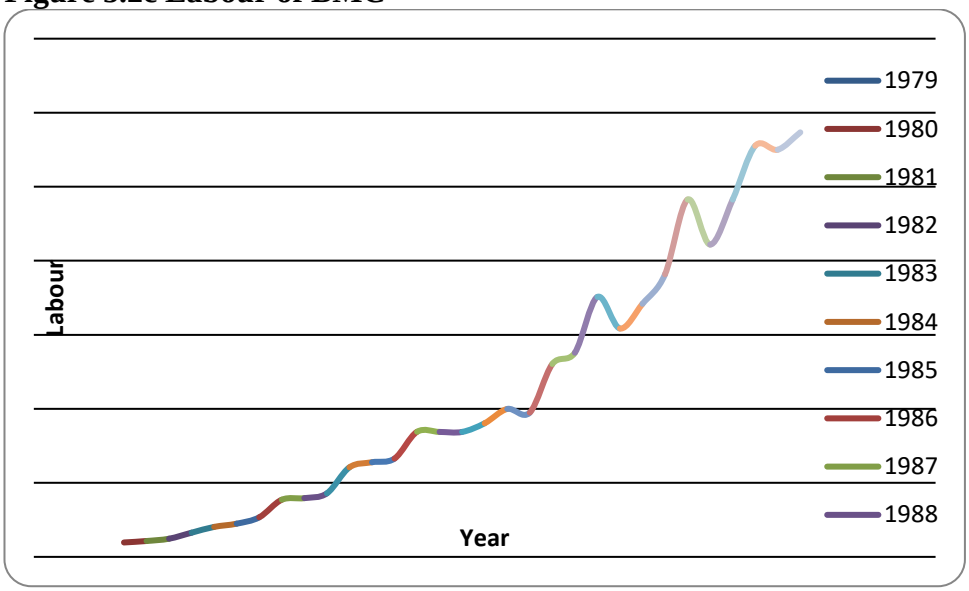
Figure 5.2b Capital of BMC



Source: Author's Estimation

The graph shows from the 1979 up to mid 1980's value of capital input has been relatively constant and from the mid 80's it rose at a steady rate. In the late 2000's there was a sharp increase in capital employed, this could be due to the increase in producer price offered by BMC which lead to a rise in cattle supplied to BMC hence the need to employ more capital. A rise in output in the same period as the rise in capital was also experienced as depicted in table 5.2a

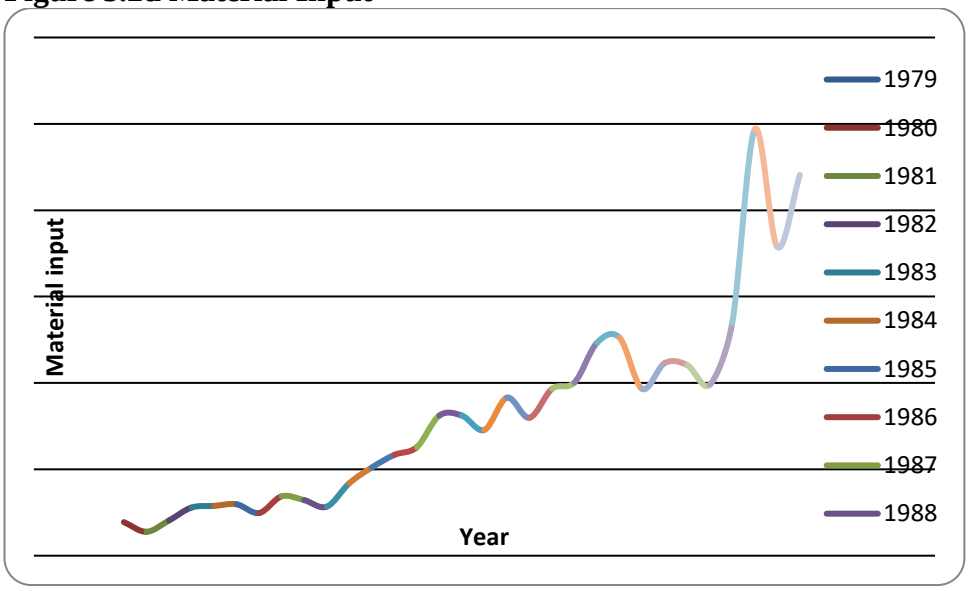
Figure 5.2c Labour of BMC



Source: Author's Estimation

The figure shows that generally over the years the value spent in labour has been rising. A steep increase in labour employed was in the late 2000's similar to a rise in capital and throughput of BMC in the same period.

Figure 5.2d Material Input



Source: Author's Estimation

Value spent on material input has generally risen over the years. Material input is characterised by fluctuations too. A sharp rise was noted in the late 2000's this could be attributed to a rise in producer prices in the mid 2000's, which gave an incentive to farmers to supply the commission with cattle due to the increased returns.

5.3 Normality test

Jacque Bera test for normality was employed in this analysis. Table 5.3 shows the results of the test. The results indicate that capital and material input are significant at 5 percent level of significance hence not normally distributed.

Table 5.3a Jarque-Bera: Skewness/Kurtosis Test for Normality

Variable	Observation	Pr(Skewness)	Pr(Kurtosis)	Joint adj chi2(2)	Joint Prob>chi2
Output	31	0.115	0.7758	2.85	0.2404
Capital	31	0.001	0.0104	15.75	0.0004
Labour	31	0.1023	0.2758	4.07	0.1309
Material Input	31	0.071	0.0998	8.46	0.0145

Source: Author's Estimation

In order to make the variables normally distributed all the variables were transformed into natural logarithnms and tested for normality. It is noteworthy that all variables were transformed into logarithmns as per the requisite of the stochastic frontier model.

Table 5.3b Jarque-Bera: Skewness/Kurtosis Test for Normality

Joint

Variable	Observation	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
lnoutput	31	0.4854	0.3090	1.64	0.4409
lncapital	31	0.1073	0.7836	2.91	0.2331
lnlabour	31	0.1938	0.2564	3.26	0.1964
lnmaterial Input	31	0.6033	0.1838	2.21	0.3314

Source: Author's Estimation

At 5 percent level of significance all the variables are not statistically significant therefore normally distributed.

5.4 Stochastic Frontier Model Estimates of Technical Efficiency

The study uses the Stochastic Frontier Model to estimate technical efficiency. The data was first transformed into logarithms. The functional form of the model is the Cobb-Douglas production function and the Translog Production Function. Table 5.4 presents the results of the estimated Stochastic Frontier Model.

Table 5.4 Stochastic Frontier Model Estimates of Technical Efficiency

Stoc. Frontier normal/half-normal mpdel Number of obs = 31

Log likelihood = 19.528979 Wald chi2(3)= 59.64

Prob>chi2 = 0.0000

lnoutput	**Coef.**	**Std.Err**	**z**	***P*** **>** **|z|**	**Level of Significance**
lncapital	-.0604328	.052511	-1.15	0.250	
lnlabour	-.3636901	.1253039	-2.90	0.004	**
lnmaterialinput	.4204189	.1343154	3.13	0.002	**
_cons	11.94637	.6570264	18.18	0.000	
/lnsig2v	-6.131983	1.033995	-5.93	0.000	*
/lnsig2u	-3.066312	.3691017	-8.31	0.000	*
sigma_v	.0466076	.024096			
sigma_u	.2158534	.0398359			
sigma2	.0487649	.0161746			
lambda	4.63129	.056046			

Source: Author's Estimation

Likelihood-ratio test of sigma_u=0: chibar2 (01) = 1.89 Prob>=chibar2 = 0.084

*, **, and*** denote significance level at 1%, 5% and 10%respectively.

Sigma u is statistically significant at all levels therefore, the null hypothesis of absence of random inefficiency effects; θ_u^2=0 is rejected. The value of sigma u indicates the variation away from the production frontier due to technical inefficiency. Sigma u of .2158534 signifies that 22 percent of the variation away from the production frontier is due to technical inefficiency.

Labour and material input are both significant at 5 percent level of significance. The natural logarithm model estimation implies that the coefficients are elasticities. Both labour and material input are inelastic to output as their elasticities are less than one

and therefore indicating decreasing returns to scale. A one percent change in the explanatory variable leads to the coefficient change in dependent variable; 1% increase in labour leads to 0.36% decrease in output and a 1% increase in material input leads to 0.42% increase in output.

After estimation, both heteroskedasticity and autocorrelation were tested for, so as to establish reliability of the results.

5.4.1 Breusch-Pagan Test for Heteroskedasticity

Breusch-Pagan/ Cook- Weisberg test for heteroskedasticity

H_0: Constant variance

Variance: fitted values of lnoutput

Chi2 (1) = 0.08

Prob>chi2 = 0.7837

The probability is greater than 0.05 which implies that the results are not significant hence absence of heteroskedasticity. Thus fail to reject the null hypothesis of constant variance. Thus, there is no need to correct the model.

5.4.2 Breuch-Godfrey LM Test for Autocorrelation

Breuch-Godfrey LM Test for Autocorrelation

Table 5.4.2 Breuch-Godfrey LM Test for Autocorrelation

lags (p)	chi2	Df	Prob>chi2
1	2.634	1	0.1046

Source: Author's Estimation

H_0: no serial correlation

From these results, the null hypothesis is accepted because of no autocorrelation in our model.

5.5 Ordered Logit Model Estimates of the Determinants of Efficiency

In order to identify the determinants of efficiency using Ordered Logit model, the dependent variable efficiency was grouped into three categories low, medium and high efficiency levels. The categories were obtained by finding the difference between capacity output and actual output and the difference was transformed into logarithms. The categories are shown in Table 5.5.1. Variables that had multicollinearity were dropped see the correlation matrix Table A.1.2 in appendix and Table A.2.1 in Appendix for the efficiency scores. The data used in the estimation was in logarithmic form hence the lack of need to compute marginal effects.

Table 5.5.1 Frequency of Efficiency Categories

Efficiency Category	Frequency	Percent	Cumulative
5	5	16.13	16.13
5.2	14	45.16	61.29
5.3	12	38.71	100.00
Total	31	100.00	

Source: Author's Estimation

Although the variation between the efficiency levels is not much it is still important to determine how explanatory variables affect each level.

Table 5.5.2 Ordered Logit Model Estimates of the Determinants of Efficiency

Efficiency	Coefficient	Std. error	Z	P>Z	Level of Significance

FMD*	.7863446	2.24192	0.35	0.726	
Inventories	5.847105	3.951719	1.48	0.139	
Price	27.32007	12.796	2.14	0.033	**
Material	-45.45422	16.86211	-2.70	0.007	**
Pula /Rand	-40.77002	23.22552	-1.76	0.079	***
Pula/Pound	-42.501	22.82131	-1.86	0.063	***
Inflation	10.03909	8.500279	1.18	0.238	
Years	-.404809	.7642718	-0.53	0.596	
/cut1	-112.189	50.96601			
/cut2	-104.7014	49.27894			

Source: Author's Estimation

(*) dy/dx is for discrete change of dummy variable from 0 to 1

*, **, and*** denote significance level at 1%, 5% and 10%respectively.

The ancillary parameters, /cut1 and /cut2 are the cut points used to differentiate the adjacent levels of efficiency.

5.5.1 Price

Table shows that price is significant at 5 percent with a positive coefficient. Price is the producer price set by the commission offered to farmers who supply the commission with cattle. The intuition of the result is that a percent rise in the producer

price leads to a percentage increase in inefficiency. A rise in producer prices means the commission incurs more costs when purchasing cattle from farmers. A rise in producer price will lead to a rise in production costs and consequently reduce returns received by the commission from its output.

5.5.2 Material Input

Material input is significant at 5 percent level of significance and has a negative coefficient. Material input is defined in monetary terms, the value spent on material input used in the production process that is costs incurred in livestock purchases by the commission. The results imply that a percentage rise in the value spent on material input will result in percentage reduction in inefficiency. Increased material input leads to a rise in throughput which will improve efficiency of the commission.

5.5.3 Exchange Rate

The Pula/ Rand and Pula/ Pound exchange rate are significant at 10 percent level of significance. The exchange rate measures how much pula is needed to a unit of foreign currency. The coefficients are both negative which implies that a percentage rise in exchange rate which means depreciation of the domestic currency will lead to a percentage decrease in inefficiency. Depreciation of the domestic currency means the commission's throughput becomes cheaper or more affordable hence improving its competitiveness in the world market. The improved competitiveness in turn leads to increased demand which will prompt the commission to increase throughput leading to improved efficiency.

5.6 Comparison with Other Studies

5.6.1 Similarities in Findings

This study found out that an increase in material input reduces inefficiency hence improve efficiency of BMC. This finding is similar to a study by Keramidou *et al*. (2010) which established that a firm can obtain better results in terms of performance from high level of prepared meat products due to a rise in material supplies and higher demand.

It was also established in this study that, depreciation of the domestic currency makes the commission's products affordable which in turn drive up demand leading to increased throughput and efficiency. Hali *et al*. (2002) found similar results in their study. The study found out that depreciation of the rupiah helps the international competitiveness of the Indonesian industry.

5.6.2 Differences in Findings

Outbreak of foot and mouth disease was found to have no significance on efficiency which is contrary to findings by Otieno *et al*. (2008). Their study established that occurrence of foot and mouth disease and rift valley fever derailed the country's capacity to competitively participate in beef export trade due to inconsistencies in throughput. The difference in findings could be due to the use of different methods of analysis. Considering disease outbreak only in export zones not the whole country in this study, could also be attributable to the difference in findings.

Another difference is the age of the firm which was found not to be significant which is contrary to Pitt and Lee (1980), who found that age of the firm among other factors had a positive influence on firm efficiency. The argument is that as the years of operation increase it means the firm has acquired experience in dealing with production challenges and any other and has managed to overcome them therefore it is in a better position to perform well.

This study argues that producer price has influence in explaining efficiency of BMC as it was significant, producer price determines the decision of farmers whether to supply the commission or private institutions like butcheries which are believed to offer better rates. This argument is substantiated Jefferis, K (2007), who argues that BMC prices have fallen over time in real terms, and it has been identified as one of the factors that has caused cattle sales to BMC to fall. The expectation is that higher prices will contribute to restoring the viability of the beef and cattle sector by stimulating increased production through improved productivity and higher off take and thereby addressing the low throughput problem that has bedevilled BMC.

5.7 Conclusion

This chapter presented the findings and also comparison with other studies. The next chapter deals with the conclusion and policy implication of the findings.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATION

6.0 Introduction

This chapter provides the conclusion of the study based on the analyses of the econometric estimations. It also presents policy implications of the findings, limitations of the study and areas for further research.

6.1 Conclusion and Policy Implication

The results of the Stochastic Frontier Model show that Botswana Meat Commission is technically inefficient because Sigma u is statistically significant. Thus the null hypothesis of absence of random inefficiency effects is rejected. Furthermore, both

components of the error term, sigma square v and sigma square u are significant at 1 percent level of significance. Sigma u of 0.22 indicates that 22% of the variation away from the production frontier is due to technical inefficiency.

The estimates of the Ordered Logit Model show that producer price, material input and exchange rate have influence on efficiency of BMC, hence they important in improving performance of Botswana Meat Commission. Producer price has positive influence in inefficiency while material input and exchange rate have a negative influence in inefficiency.

Given the potential that the beef sector possess in terms of employment, diversification of the economy and export earnings, reducing poverty level particularly in rural areas and backward linkages with other sectors this necessitates strategies aimed at improving performance of this sector. One of the options that can be explored is opening up of the market; introduce competition which from experience has proven to be a good stimulus to performance and will lead to producer prices being competitively set. Another option is further processing of by products such as horns and leather. Processing of these products will aid in diversifying the products portfolio of the commission which will also increase returns. Furthermore, another option that can be explored is outsourcing of further processing of by products, so as to ensure that the commission concentrates on efficient production of beef and beef products.

6.2 Limitations of the Study

The main limitations of this study are the scope of the study, variables used in estimating determinants and the quality of the data used. With regards to the scope of

the study, the time period covered only 31 years while BMC has been in operation for 46 years. The problem for the short time period resulted from lack of records dating backwards from 1979.

With reference to the variables used for estimating determinants, not all variables that could help explain efficiency were exhausted. For instance variables such as training or education level of staff and technology advancement in the production process among others, could have helped in explaining efficiency, so more variables could have been explored.

The data was sourced from BMC annual reports. The format of reporting in these reports has changed overtime and has resulted in some components being not reported anymore which made it impossible to use them in the analysis.

6.3 Area for Further Studies

There is a need to conduct an extensive analysis of efficiency of BMC. Currently two out of three abattoirs are in operation; a comparison study between the two can be undertaken and identify unique characteristics that aid in explaining their performance status.

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APPENDIX I

CORRELATION MATRICES OF INDEPENDENT VARIABLES

Table A.1.1 Correlation Matrix, Stochastic Frontier Model

	lncapital	lnlabour	lnmaterial input
lnoutput			
lncapital	1.0000		
lnlabour	0.9581	1.0000	
lnmaterial input	0.9068	0.9649	1.0000

Variables included in the Correlation Matrix in Table A.1.2

FMD	Foot and Mouth Disease
K	Capital
L	Labour
Inv	Inventories
Price	Producer Prices
Mat	Material Input
Rand	Rand-Pula Exchange Rate
Pound	Pound-Pula Exchange Rate

Inf Inflation Rate

Age Number of operation years

Table A.1.2 Correlation Matrix, Ordered Logit Model

	FMD	K	L	Inv	Price	Mat	Rand	Pound	Inf	Age
FMD	1.000									
K	0.375	1.000								
L	0.441	0.958	1.000							
Inv	0.261	0.872	0.911	1.000						
Price	0.391	0.919	0.974	0.879	1.000					
Mat	0.430	0.907	0.965	0.880	0.942	1.000				
Rand	-.014	0.635	0.631	0.576	0.682	0.533	1.000			
Pound	-.549	-.934	-.968	-.822	-.948	-.946	-.546	1.000		
Inf	-.085	-.387	-.437	-.322	-.447	-.406	-.310	0.486	1.000	
Age	0.561	0.917	0.979	0.858	0.953	0.965	0.522	-.987	-.448	1.000

APPENDIX II

EFFCIENCY SCORES OF BOTSWANA MEAT COMMISSION

Table A.2.1

Years	Efficiency Scores	Efficiency Scores*100
1979	.7998163	79.98
1980	.6072663	60.73
1981	.777606	77.76
1982	.8987265	89.87
1983	.9314193	93.14
1984	.9597105	95.97
1985	.936064	93.61
1986	.968035	96.80
1987	.711702	71.17
1988	.6901546	69.02
1989	.7948694	79.49
1990	.8148555	81.49
1991	.9466271	94.66
1992	.9791399	97.91
1993	.8344826	83.45
1994	.8716086	87.16
1995	.9038035	90.38
1996	.8016614	80.17

1997	.7011493	70.11
1998	.9387005	93.87
1999	.8335138	83.35
2000	.9369683	93.70
2001	.9399002	93.99
2002	.7408608	74.09
2003	.928544	92.85
2004	.8952304	89.52
2005	.8153254	81.53
2006	.9231052	92.31
2007	.9363417	93.63
2008	.7221383	72.21
2009	.7351124	73.51

Source: Author's computation from Efficiency of BMC