

Effects of trade liberalisation on technical efficiency in Zimbabwe's cropping sector.

BY

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A project submitted in partial fulfilment of the requirements of a Bachelor of Science Honors degree in Agricultural Economics and Development.

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April 2018

Our Hands Our Minds Our Destiny

CERTIFICATION OF DEDICATION

This serves to certify that they have read and recommended for submission to department of Agricultural Economics and Development , in partial fulfilment of the requirements for the Bachelors of Science Honors Degree in Agricultural Economics and Development , a dissertation by Buhlebenkosi A Ncube titled;

Effects of trade liberalisation on technical efficiency in Zimbabwe’s cropping sector.

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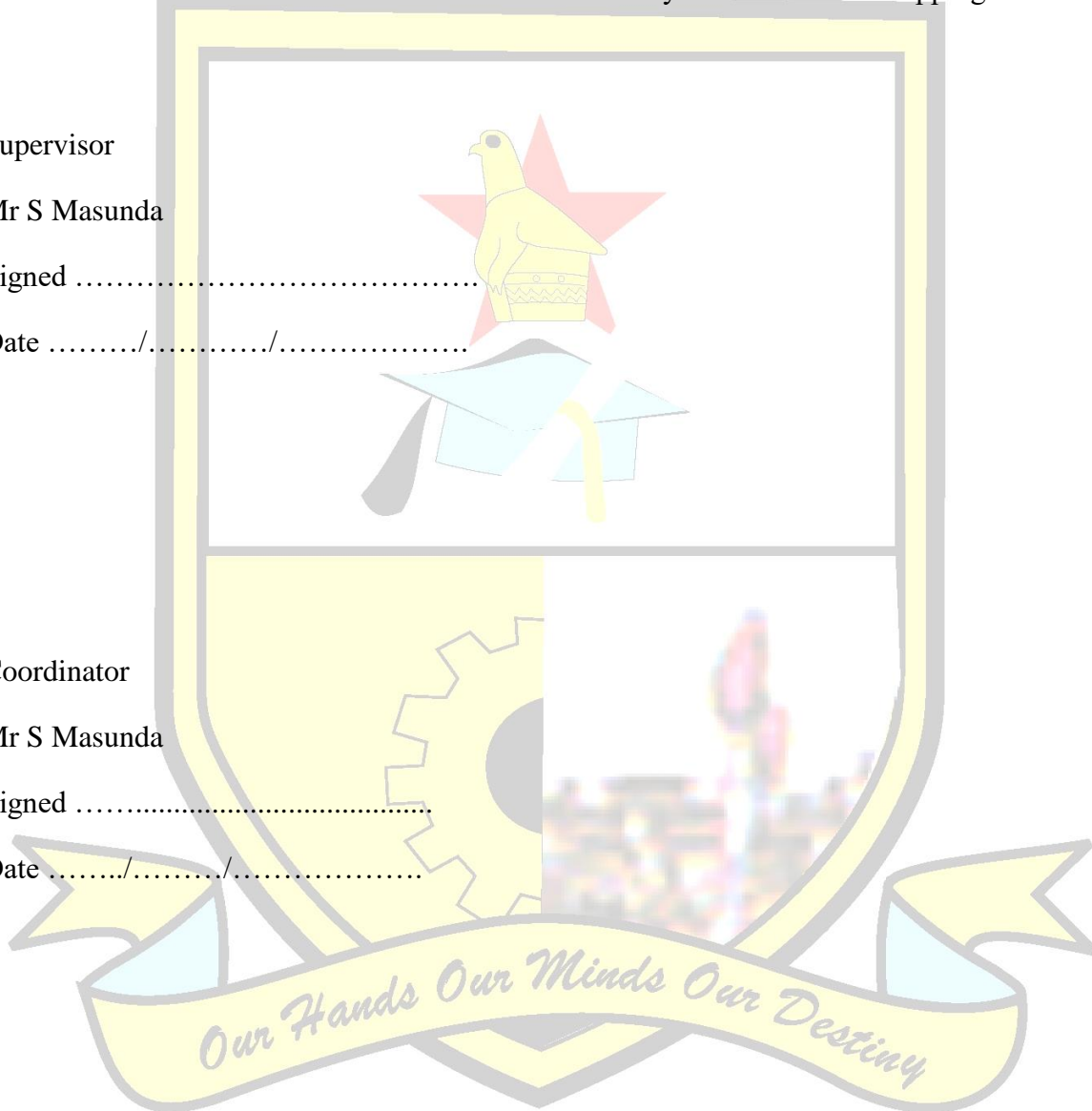
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Dedication

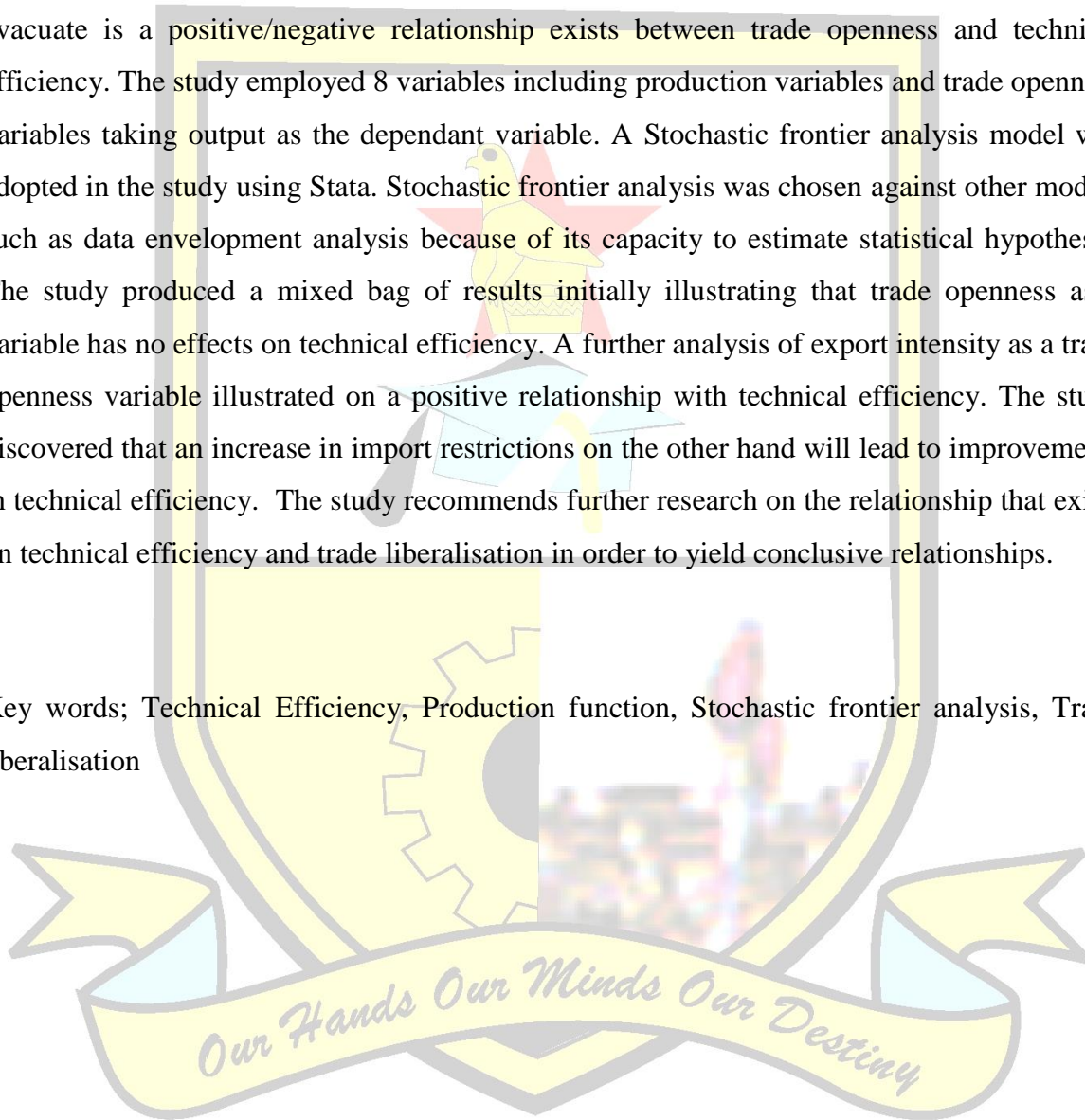
This dissertation is dedicated to my wonderful mother and my fiancé Simkhonzeni Tshuma who has been there for me in prayer and sacrifices in order for me to pass my dissertation.



ABSTRACT

The study was aimed at investigating the effects of trade liberalisation on technical efficiency taking Zimbabwe cropping sector as a case study. The study was a time series analysis with 30 observations being reviewed from 1985 to 2015. The motive of the study was basically to investigate whether an association exists between trade liberalisation and technical efficiency. The main objectives of the study were to estimate the level of technical efficiency and to evaluate if a positive/negative relationship exists between trade openness and technical efficiency. The study employed 8 variables including production variables and trade openness variables taking output as the dependant variable. A Stochastic frontier analysis model was adopted in the study using Stata. Stochastic frontier analysis was chosen against other models such as data envelopment analysis because of its capacity to estimate statistical hypothesis. The study produced a mixed bag of results initially illustrating that trade openness as a variable has no effects on technical efficiency. A further analysis of export intensity as a trade openness variable illustrated a positive relationship with technical efficiency. The study discovered that an increase in import restrictions on the other hand will lead to improvements in technical efficiency. The study recommends further research on the relationship that exists on technical efficiency and trade liberalisation in order to yield conclusive relationships.

Key words; Technical Efficiency, Production function, Stochastic frontier analysis, Trade liberalisation



ACRONYMY

FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
IMF	International Monetary Fund
SFA	Stochastic Frontier Analysis



ACKNOWLEDGEMENTS

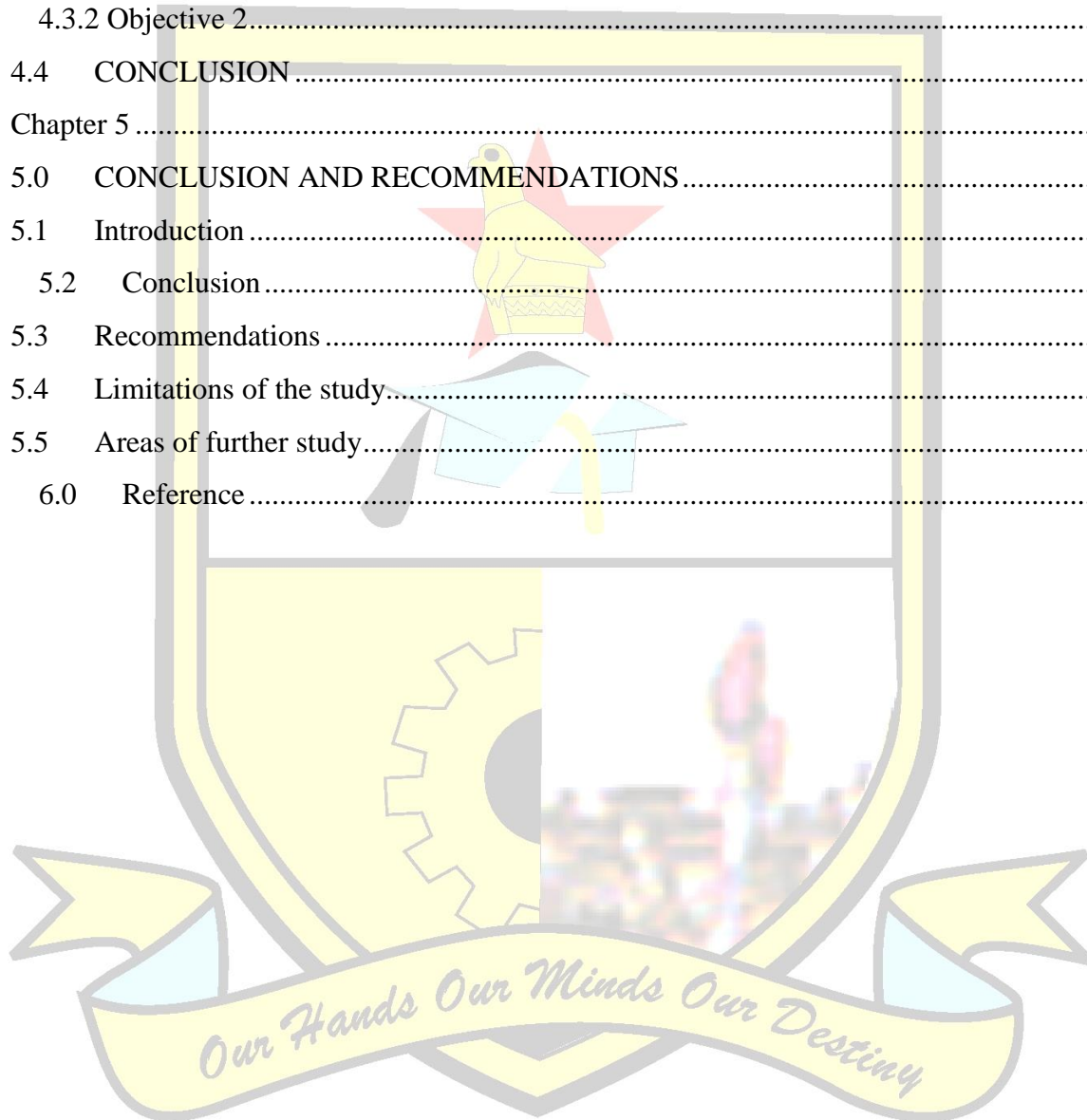
I would like to thank my Lord who saw me through the writing of this dissertation. The final outcome of the document required guidance, severe mentorship and assistance. Initially I would like to thank my supervisor Mr S Masunda for the patience and his assistance on the drafting and writing of the dissertation. More so would like to acknowledge the help I acquired from Mr Mupaso and Mr Chipunza. I would also like to acknowledge my mother and my family for their support both financially and emotionally. Lastly I would like to acknowledge my fiancé Simkhonzeni Tshuma who was my helping hand throughout the process of data collection and one who kept me motivated to finish and pass.



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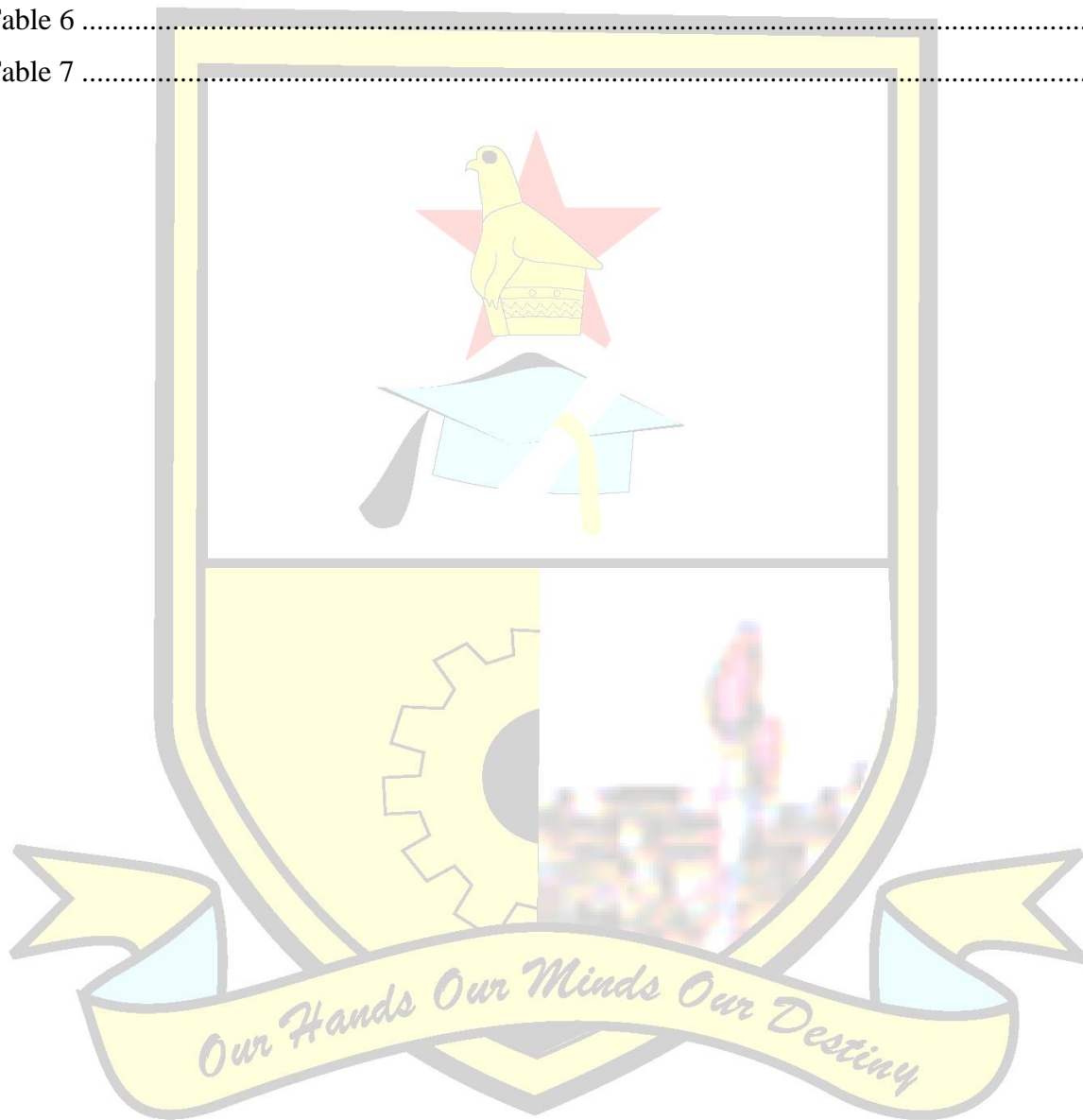
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CHAPTER 1

1.0 INTRODUCTION

1.1 Background

“Free trade allows a country to compete in the global market according to its fundamental economic strengths and to reap the productivity and efficiency gains that promote long-run wealth and prosperity.”Markheim (2007)

Trade policies have undergone massive changes over the past decades from trade protectionism to trade liberalisation for both developed and developing countries (Phan, 2004). As explained by the statement above, the main reason for transition was to promote growth, productivity, improve efficiency and economic development. The adoption of trade openness policies was a recommended technique by IMF and World Bank to developing countries under the Structural Adjustment programmes in order to aid economic growth rates, adopt industrialisation and promote institutional capacities (Phan, 2004). The main concept of free trade however dated from Adam Smith and David Ricardo’s theories of international trade during the 18th and 19th century that asserted that free trade between two countries must bring advantages to both economies in order to facilitate prices of commodities to be determined by market forces of demand and supply. In addition to, traditional trade theories suggest that free trade enhances productive and allocative efficiency levels assuming perfect competition thus improving national welfare levels (De Silva, Malaga and Johnson, 2013). It is assumed that free trade over the years has led to improvements in resource accessibility, reduction in poverty levels, improvements in foreign currency generation and production of high value commodities due to increases in international competition levels (Harrison and McMillan, 2007).

Yannikaya (2013) asserts that there is no precise definition of trade liberalisation. Djokoto (2013) further explains that trade liberalisation can be classified into three distinct components; trade to gross domestic product (GDP) ratio, import penetration and export intensity (Miljkovic and Shaik, 2013). Trade to GDP ratio, import penetration and export intensity as components of trade openness is the ratio of imports and exports to GDP, imports to GDP and exports to GDP respectively (Djokoto, 2013). In theory, Lee (2005) defines trade liberalisation as a movement to a trade free economy through the removal and reduction of trade restrictions (tariffs, customs duties, non-tariffs barriers and quotas). Trade liberalisation

is assumed to have positive effects on technical, allocative and productive efficiency (Phan, 2004). However a number of studies have been conducted in order to view the effects of trade liberalisation on technical efficiency in Agricultural sector (Miljkovic and Shaik, 2013; Murakami, 2013; De Silva, Malaga and Johnson, 2013; Djokoto 2013; Miljkovic and Shaik, 2010; and Kazungu, 2009) the results obtained however are inconclusive to the relationship that exists between trade liberalisation and technical efficiency. Miljkovic and Shaik (2010) assert the reason for the lack of consensus of empirical evidence is the lack of theories that explain the relationship between trade openness and technical efficiency. The relationship between trade liberalisation and technical efficiency is perceived differently among various authors depending on the economies under review and variables (Miljkovic and Shaik, 2010; Hart, 2014; Iyer, Rambaldi and Tang, 2008).

The extent at which trade liberalisation are implemented from one country to the next differs depending on the number of countries involved and the policies the country holds. The countries involved in trade openness can either be regional, bilateral and multilateral (Makotsekanwa, Hurungo and Kambarami, 2012). Empirical evidence on the impacts of trade liberalisation and technical efficiency illustrates a mixed bag of results where Djokoto(2013);Hart (2013) discovered that trade openness leads to a decrease in technical efficiency , Aedo(2011) discovered a positive effect and Miljkovic , Miranda and Shaik(2013) stated that an increase in trade liberalisation has no effect in technical efficiency. Therefore the aim of the study is to evaluate the effects of trade liberalisation on technical efficiency in Zimbabwe's Agricultural cropping sector.

1.2 Problem Statement

The main motivation of the research is driven by the problem currently prevailing on the lack of consensus on the relationship that exists between trade liberalisation and technical efficiency. Trade liberalisation according to (Markheim, 2007; Phan, 2004) was a policy that is implemented in order to improve a country's level of production, poverty levels in the society and accessibility of resources (Harrison and McMillan, 2007). However some studies conducted have shown no to negative changes to technical efficiency levels regardless of the theoretical benefits assumed to be brought about by trade free policies (Iyer, Rambaldi and Tang, 2008). Iyer, Rambaldi and Tang (2008) further assert that the reason for the existence of the lack of consensus of empirical evidence on the relationship between trade liberalisation and technical efficiencies' is because of the absence of theories that link the two parameters under review. Trade liberalisation and technical efficiencies' are subject to how sustainable

policies are in a particular economy. However this does not imply that trade liberalisation has no positive effect on technical efficiency changes (Djokoto, 2013) therefore this study is aimed at analysing whether or not trade liberalisation has effects on technical efficiency on Zimbabwe's Agricultural sector.

1.3 Research Objectives

The main objective of this study is to evaluate the effects of trade liberalisation on technical efficiency in Zimbabwe Agricultural Cropping Sector.

1.3.1 Specific Objectives

- i. To estimate the level of technical efficiency in Zimbabwe Agricultural Sector
- ii. To assess whether trade liberalisation affects technical efficiency.

1.4 Research Questions

- i. What is the extent of technical efficiency in Agricultural Sector?
- ii. What is the effect of trade openness on technical efficiency?

1.5 Motivation of study

Phan (2004) stated that most of the research work on trade liberalisation has generated different outcomes results, either portraying a positive, negative or constant effect on technical and productive efficiencies. It is of paramount importance therefore for further studies to be conducted on the effects of trade liberalisation and technical efficiencies in order to add on empirical evidences to the subject matter (Miljkovic and Shaik, 2013). Djokoto, (2013) further asserts that it is essential for studies to be carried out on trade liberalisation on agricultural sector as it provides information to trade policy makers on the benefit of trade openness to economy and whether or not to open trade to agricultural cropping sector. However since agriculture is the back bone of most developing countries as it provides the greatest percentage of GDP and employment (Dull, 2014) hence it is essential to investigate and focus on the agricultural field more as it is of concern to all the classes among the society. The aspect of technical efficiency and trade openness has been an issue of discussion between economists for a number of years hence the need for further studies to be undertaken

in order to yield uniform results that can be used in theory formulation between the concept of trade liberalisation and technical efficiency (Phan, 2004; Miljkovic and Shaik, 2013; Kazungu, 2009). It is assumed that if technical inefficiencies exist there is either a condition of market failure or institutional differences that exist between public and private owned rights. Therefore it is essential for there to be a situation and condition of efficiency technically on agricultural produced commodities. Studying trade issues is of paramount importance as it can boost a country's wealth, production levels and foreign currency generation. Whether there is need for trade liberalisation to exist on agricultural commodities is still a subjective issue hence this study will aim at focusing on agriculture to examine the effects of free trade on technical efficiency changes in Zimbabwe.

1.6 Organisation of Study

This study is divided into five main chapters namely introduction, literature review, methodology, results interpretation and conclusion. The study therefore proceeded as follows; the next chapter reviewed literature on trade liberalisation theories and the aspect of technical efficiency. More so it reviewed theoretical and empirical evidence of findings by other scholars on the effects, causality and relationships between technical efficiency and trade openness on agricultural sector and insights of literature. Empirical study will explain the findings other scholars acquired from undertaking the related study, variables used, country of study and comparisons from the observations giving the different techniques undertaken in data analysis.

Chapter Three discussed the methodology used in this study. It furthermore explains research design stating the various sites used upon data collection, justification of variables, explanation of econometric models that were used in the study, conceptual framework that links the related variables and lastly analytical tools that will be employed in the study. The models for data analysis are explained in this chapter and diagnostic tests are highlighted in brief however the results were analysed in detail in Chapter Four where data was grouped against the objectives under review. The data analysis, research finding and interpretation were detailed in this chapter.

The concluding chapter stated results summary and recommendations according to the outcome acquired from data analysis. More so it explained further studies that can be undertaken in order to widen research on trade and efficiency relationships.

Chapter 2

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter aims at explaining linkages between trade liberalisation and technical efficiency using various theories and explain experiential and empirical literatures and findings on the related topic under review.

2.2 Background of study

In the past decades, many developing countries have moved from importing more inputs and final products to increases in exports both of inputs and outputs. This has been through use of export incentives, advancement of infrastructure and fluctuating exchange rate. Free trade policies were the most vital trade policies that were implemented by both developed and developing countries between the periods of 1970 to the beginning of 1990s (Aedo 2011). Furthermore, Aedo (2011) explains that for a country to embark on development and growth, it is inevitable for growth to occur without implementing strategies that promote trade, increasing exports and increases in foreign currency sources (Aedo 2011; IMF 2001). Over the years Zimbabwe signed a countless number of trade protocols and agreements (COMESA trade agreement for exports and Zimbabwe vices Namibia export trade protocols) with various countries that however brought both positive and negative outcome (ZIMRA Trade Agreements, 2014). Amongst the goods stated in the protocols to be traded are agricultural products that have fully matured and off higher grades. The implementation of free trade policies is an on-going practice that is assumed to yield more benefits both productively and technically. With the various benefits that are assumed to be brought by trade openness, this topic has attracted the eye of many scholars.

2.2 Definition of terms

2.2.1 Technical efficiency

Technical efficiency can be defined using two main aspects; inputs and outputs. Quattara (2012) defines technical efficiency as the state of efficiency in which the highest level of output is produced given the least inputs employed. In (2006) Briecs further explains the condition of technical efficiency as a degree of measure on which increases in production can be achieved without consumption of an additional unit of input. If production is said to be

technically efficient, reduction in an input can yield the same level of production. Therefore the main definition that will be employed in this study is according to Farrell (1957) that states that for there to exist technical efficiency an economy must be producing the highest possible outcome given a set of inputs that are correctly measured.

2.2.2 Trade liberalisation

Trade liberalization also known as trade openness infers change leading to a nation's trade system towards impartiality in order to bring the nation towards the situation that would prevail assuming no government intervention in trade and confers no apparent incentives to either the importable or the exportable activities of the economy (Papageorgiou, 1991). Lee (2005) defines trade liberalisation simply as the movement to a trade free economy through the removal and reduction of trade restrictions being tariff and non-tariff barriers. Trade liberalisation as according to (Dean, Desai and Riedel, 1994) is defined as a form of openness in trade however that does not imply complete removal of all restrictions. The definition that will be employed in this study is that trade liberalisation is a situation where there is a form of neutrality among the countries trading meaning reduced government intervention on setting trade restrictions (Dean, Desai and Riedel, 1994; Thomas and Nash, 1991).

2.2.3 Production function

Production function in simple terms is a function that illustrates the relationship between input employed and output produced. Fioretti (2008) defines production function maps the relations that exist between output and inputs. This study will therefore employ the definition that explains production function as a relationship that exists between factors of production and produces (Fioretti, 2008).

2.2.4 Stochastic frontier analysis

Stochastic frontier analysis (SFA) is an econometric technique that is used to model behaviour of producers. More so SFA can be defined as techniques used for statistical analysis of production functions in order to account for existence of inefficiencies (Dennis, 1997). The definition that will be used in this study is that it is a model that is used to illustrate technical inefficiencies that exist in production functions (Mastromarco, 2008). This model allows to decompose growth into three main segments; efficiency changes, changes in technology and changes in consumption of inputs.

2.3 THEORETICAL FRAMEWORK

2.3.1 Trade liberalisation

As stated above trade liberalisation is a state of reduction in government intervention in order to promote trade between various countries. In some instances, trade liberalisation is referred to as liberality to trade, reduction in import restrictions, promotion on use of export incentives and lastly reduction in export biasness (Dean, Desai and Riedel, 1994). Adam Smith famous theory of absolute advantage states that a country must produce a good in which it has absolute advantage in. Following this theory, economists main argument is that if all countries were to produce goods in which there are best at producing therefore there will be limited wastages of resources hence implying that trading of commodities that a nation has absolute advantage will improve allocative efficiency (Lewis, 2004). How sustainable trade liberalisation policies are is still debatable (Phan, 2004, Lewis, 2004). Phan (2004) states that bigger countries with more natural resources are less lightly to adopt to trade liberalisation policies as opposed to small countries with lesser natural resource base. Phan (2004) however in his argument does not however highlight the parameter that measures how big or small a country is.

There are three main reasons that lead to countries adopting trade openness; economic difficulties or in adequacies', as an economic decision to aid growth and development and lastly as a way to create relations with other countries. Thomas and Nash (1992) states that the rate in which a country adopts trade liberalisation policies will defer both in intensity and time. For example one country can adopt trade openness overnight whereas another over a long period of time. Trade liberalization in general is thought to lead to increases in globalisation levels due to increases in openness of traded commodities through reduction and elimination in trade restrictions. Over the years increases in trade liberalisation is assumed to have brought about increases in economic growth and development through the free flow of goods across various countries. It is however the most argumentative aspects of globalization.

Trade liberalisation critics assert the blame of increase in unemployment rate, decreases in wage rate, manipulation of employees developing nations by developed nations, decreases in standard of living of citizens and devaluation of the environment to trade openness between developed and developing countries. The views as according trade liberalisation expect

implies that protectionism in general is anticipated to cause a decrease in both productive and technical efficiency level.

2.3.2 Relationship between trade liberalisation and technical efficiency

The relationship between trade liberalisation and technical efficiency is indefinite meaning recent studies conducted on agriculture as a sector realised an outcome that are not uniform (Rodrik, 1988). Theoretically, due to trade openness, firms are assumed to improve level of production due to increases in competition of international firms. More so, it is assumed that trade openness will facilitate increases in income acquired from exporting goods hence relaxing technological efforts of firms leading to production of less efficient commodities (Hart, 2004). Miljkovic and Shaik (2010) asserts that trade openness is expected to increase technical efficiency however Rodrik (1988) argues that large farms with a fixed and great market dominion, due to availability of productivity-enhancing technology, will produce more quantities of output regardless of the quality. With this effect, smaller firms are forced out of the market because of the limitations of operating at small scale. With this regard, the main question that persists according to the above mentioned scenario is that does trade openness lead to an aggregate improvement of technical efficiency or it can be subjective to the size of the farm? Technical efficiency is a component of productivity which can be enhanced through trading of commodities (Rodrik, 1988). It is substantial to differentiate two mechanisms: Technological Change and Technical Efficiency. Movement from one production possibility frontier is facilitated by technological changes however movements away and towards the frontier is termed technical efficiency changes being the difference between observed and expected output produced. Trade can typically lead to positive technological change but however can result in either a positive or negative outcome in technical efficiency change (Iyer, Rambaldi, and Tang, 2008).

Sachs (1987) states that trade liberalization is driven by philosophy and ideology rather than economics hence it is difficult to estimate effects of trade liberalisation to technical efficiency. Shaik and Miljkovic, (2011); Miljkovic, Miranda, and Shaik, (2013) concluded that there is no relationship that exists between trade liberalisation and technical efficiency on agricultural sector in two developed countries, Brazil and U.S. Hart 2004 asserted that the main reason Shaik and Miljkovic, (2011) and Miljkovic, Miranda, and Shaik, (2013) did not find causality was because the variables estimated in the stochastic frontier model excluded foreign direct investment. There is no consensus that exists on the relationship between efficiency and trade openness. Miljkovic, Miranda and Shaik, (2013) associate the lack of

consensus to lack of systematic theories linking technical efficiency to trade openness. However there are theories that explain trade growth and efficiency at large. These include;

New trade theory that came after the standard trade theory in order to resolve the shortcomings of the theory by bringing realistic trade reviews. New trade theory states that regardless of the fact that previous literatures link both trade and growth theories as those that promote free trade on the grounds of knowledge and technological spill overs, the aspect of free trade can be detrimental to economic development and growth. New trade theory states that there are two main determinants of trade; economies of scale and network effects. New trade theory came after David Ricardo's theory of comparative advantage that states that a nation must produce goods with the lowest opportunity cost as opposed to other nations. The main ideology behind new trade theories was that when firms operate and enjoy economies of scale, returns will be increased.

The new trade theory asserts that in a particular industry, monopolistic competition is bound to exist as increases in economies of some firms will lead to phasing out of infant industries. In this view, assuming firms from a developing nation and those from a developed compete, it therefore means that due to technological advancements of industries in developed countries, developing country industry will be forced to rest. Furthermore, Krugman therefore advocates the need for government intervention and trade protectionism in order to protect industries. Hence the new trade theory stipulates that free trade must only exist in developed economies with the capabilities to compete in international markets. The significance of new trade theory is questionable (Bardhan 1995; Ruttan 1998) as the theory is biased towards developing countries hence the aspect of technical efficiency changes as a result of new trade theories in developing countries is debatable.

On the other hand new trade theories are cohesive to new growth theory. This is so because new growth models focus on market imperfections on variable growth rates. Growth rate as according to the endogenous theories is assumed to improve with increases in government policies and practises that promote savings and incorporate savings. Endogenous growth models and trade are adversely linked by the two basic mechanisms being technology and knowledge spill overs. Grossman and Helpman (1991) states that trade on both have positive and negative effects on research and development as it can either boost technology, increase competition and aid innovations in agriculturally produced commodities however trade can pose to display innovative mechanisms of a firm to competitors.

2.4 Empirical Review

The concept of trade liberalisation is not an unknown phenomenon however it is not overall researched on due to the lack of theories to determine the relationship that exists between technical efficiency and trade liberalisation. The results from various studies that were undertaken on this topic have illustrated no common outcome on causality between the above mentioned concepts.

Miljkovic, Miranda and Shaik (2013) conducted a study on the contribution of trade openness to technical efficiency in agriculture. The study employed use of stochastic frontier analysis model. Miljkovic, Miranda and Shaik (2013) used panel data of between the years of 1990-2005. The panel data was organised in periods of 5 years between 27 cross sectional Brazilian countries. The results suggested that technical changes led to increase in outputs produced in these Brazilian countries however an overall view suggested that trade openness does not affect technical efficiency changes. Miljkovic and Shaik (2010) conducted an impact assessment on trade liberalisation and technical efficiency on US agricultural sector. Similar results were obtained. Miljkovic and Shaik (2010) discovered that a change in the agricultural exports on GDP has no effect in technical efficiency however a reduction in the agricultural share of imports will enhance positive changes in technical efficiency.

Aero (2011) states that for studies carried out investigating technical efficiency and trade liberalisation are grouped into two categories being production function studies and total factor productivity studies. Salim and Hossain (2006) investigated the impacts of trade openness on agricultural products using a production function study. This study employed use of Cobb Douglas model and stochastic frontier analysis technique. This model consider land use, education, infrastructure, exports, non-agricultural income earned and trade openness as variables. The results illustrated that there is an 8% increase in technical efficiency rate from 1977 (pre reform) at 0.56 to 0.64 in 1997. This study concluded that infrastructure, education and income acquired from non-agriculturally based activities have a positive effect on farm specific technical efficiency. In the same vein, Murakami (2013) analyse how technical efficiency of Mongolian livestock in an open economy. Murakami discovered similar outcomes after conducting a stochastic frontier analysis between the periods of 2001 to 2011. Murakami concludes that trade liberalisation is most important determination of technical efficiency. However technical efficiency was said to be regressive after 2009 instead of being progressive.

Djokoto (2013) carried out a study of examining the effect of trade openness on technical efficiency change between the periods of 1980 to 2010 on Ghana's agricultural production. This study followed an estimation of Cobb Douglas production function and it employed the use of Stochastic Frontier Analysis. The outcome of was that according to data collection from Ghana's agricultural ,the statistical log likelihood ratio test against the OLS model stated that there is change in technical efficiency however the change is negative. This is so because trade liberalisation measured was negative and the coefficient's where greater than 1 meaning an increase in trade openness meant a reduction in technical efficiency.

Hart (2013) studied the impacts of trade openness on technical efficiency of case of European Union. The main objective of the study was to evaluate if trade openness will impacts and changes in technical efficiency. Data has collected 1980 to 2007 for 16 European countries. A stochastic frontier analysis was used using a Cobb Douglas function. Results indicated that for each of the European countries, trade openness did not necessarily impact technical efficiency in the short run. Hart (2013) goes on to explain that there is an instantaneous decrease in technical efficiency is noted in the short run taking into consideration foreign direct investment as a variable however when time factor is introduced, technical efficiency tends to improve. Hart (2013) attributed this change to the fact that initial upon entry of new countries to trade , European countries must increase technology of in order to remain competitive however in the long run improvements can be noted in technical efficiency.

2.5 Insights to Literature

A number of literatures have been written concerning the effects/ impacts of trade liberalisation on technical efficiency over the past years. Literature reviewed concludes that in theory, trade openness must lead to an increase in both productive and technical efficiency levels. However the practical aspect as according to reviewed literature illustrates that trade liberalisation policies either show an instantaneous decrease in technical efficiency in the short run as illustrated by Hart, (2010) and Djokoto, (2013). Aedo (2011) some variables for example infrastructure, education and income are said to have a positive bearing on enhancing positive changes in technical efficiency levels.

Chapter 3

3.0 METHODOLOGY

3.1 Introduction

This chapter will evaluate the effects of trade liberalisation policies on technical efficiency for Zimbabwe. Variables of both technical efficiency and trade liberalisation will be explained and how the research will be conducted. It will explain how stochastic frontier analysis will be employed in the modelling of establishing the relationship of trade liberalisation and technical efficiency. Data will be captured and analysed using Stata.

3.2 Research design

This study on technical efficiency and trade liberalisation will make use of secondary quantitative data that will be obtained from FAO databases, ZIMSTATS and World Bank databases. This study will employ the use of quantitative secondary data taking Zimbabwe Cropping Sector for analysis. Secondary data is essential as it enables the use of descriptive analysis of the variables under review. Secondary data in its nature is cheaper to acquire, requires lesser time to compile and is economically efficient.

3.3 Conceptual framework

Conceptual framework is a framework that illustrates the linkages of variables of parameters that are estimated. Due to the scarcity of the number of articles linking trade openness and technical efficiency, no diagrammatic linkage of variables was acquired. This study will follow the basic assumption that trade openness will cause existence of technical inefficiencies in agricultural sector (cause and effect relationship). Following the graph illustrated below, two assumptions are made; assumption of constant returns and that an efficient level of production is known. Isoquant SS illustrates the output produced and graph P illustrated two inputs employed in the production process. Point OQ/OP illustrates a condition of technical efficiency where point OQ illustrates the output produced given a level OP of two inputs employed. Due to the fact that the isoquant has a negative slope, an increase in input level will adversely lead to a decrease in technical efficiency *ceteris paribus*.

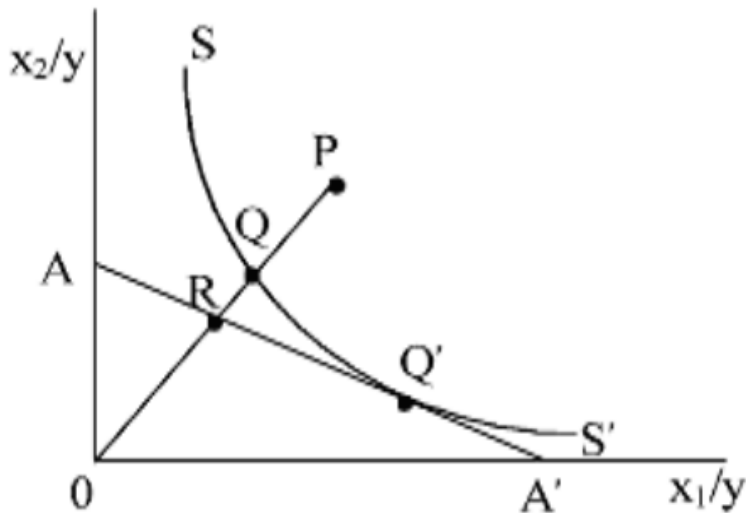


Figure 1. Technical efficiency graph

Adapted from Farrell (1957)

3.4 Econometric Model

This study will employ analysis of Stochastic Frontier Analysis instead of data envelopment analysis to evaluate the effects on technical efficiency changes as a result of trade openness on agricultural commodities in Zimbabwe (Hart, 2004). A stochastic frontier analysis as according to Batesse and Coeli (1993) is used to ensure the amount of output produced as a function of relative input used, time factor and error terms to represent technical inefficiencies that might exist and noise (Tang, 2008). The main reason for using stochastic model unlike deterministic model will yield random results. The simulation will yield different results hence this is essential as it will provide future references. Aigner (1997) developed two main approaches to measuring technical efficiency. These are one stage and two step models. One stage model (Lall, 2000) is used to estimate production function whereas the two stage model estimates production function however fails to distinguish between explanatory variables and production function. More so second stage model yields biased technical efficiency results as explanatory variables are correlated to production function estimates the value of standard deviation.

The model used in this study is

$$Y = f(x) e^{-(v-u)} \quad (1)$$

Where

Y=yields /outputs

X=production inputs

T=time

(v-u) =error terms

Phan (2004) states that stochastic frontier model is used in place of ordinary least squares hence in this study estimation of OLS will be done in order to assert if SFA is superior or appreciate OLS model. This study is based on use of stochastic frontier analysis as opposed to using data envelopment analysis. Data Envelopment Analysis (DEA) as initially developed by Charnes, Cooper and Rhodes (1978) is a method of measuring technical efficiency that is a non-parametric. DEA does not require any functional material for a particular data under review. This technique uses input and output data of decision making units to construct a piece-wise linear surface or the best-practice frontier for a given data. The best practice frontier that represent full efficiency level of the units is constructed by the solution of a sequence of linear programming problems for each units or enterprise.

DEA is used to evaluate the input usage of firm by holding output produced is constant we should use the input oriented approach. Because the input oriented DEA method seeks the maximum possible proportional decrease in input usage with a given output levels. But if our aim is to know whether maximum possible output is produced by the decision making units with a given set of inputs, we should use output oriented approach. The output oriented approach seeks the maximum possible proportional increase in output with a given set of inputs. However, under the constant returns to scale technology, these two approaches give the same results in terms of technical efficiency index, but under the variable returns to scale technology technical efficiency index may differ. DEA is used to estimate relative efficiency however it does not estimate absolute advantage. More so DEA cannot be used to calculate statistical research hypothesis. The reason why SFA was selected instead of DEA is because of the following differences;

DEA	SFA
Non parametric approach	Parametric approach
Cannot taste	Can test hypothesis
Uses mathematical programming	Uses maximum likelihood econometric estimation.
Does not accommodate noise	Separates noise from efficiency scores
Accommodates multiple outputs and inputs	Accommodates one output and multiple inputs.
Functional form must not be specified.	Specifies functional forms.

Table 1 ; Difference between DEA and SFA

3.5 Justification of variables

This study will employ two set of variables being production function variables and trade liberalisation variables.

3.5.1 Production function variables

These include the following; output, labour, capital, fertiliser and herbicides.

Output

Output as according to this study is defined by the net production value of agricultural produced commodities valued in US dollars using 2006 prices. Output will enhance the estimation of whether or not the function follows a Cobb Douglas production function. Output is an essential dependant variable in this study as it will link the other input variables under review. This information was acquired from FAO website.

Labour

Labour is defined in this study as the active population employed in agricultural sector in Zimbabwe between the years of 1985 to 2014. Labour is an independent variable and this study will explain and employ labour quantities. This data was acquired from national statistics account employed in agriculture.

Agro chemicals

Pesticides and herbicides

These are agro chemicals that are used in the process of agricultural production. Both these parameters are defined as the agro chemical use for agricultural purposes measured in tonnes of consumption. Agro chemical quantities in this study are defined as total chemicals (pesticides and herbicides) imported less export in current USD assuming zero local production. Assumption is after importing and exporting residues are consumed quantities of both pesticides and herbicides. These calculations and assumptions are essential because FAO does not provide adequate information on the period under study.

Capital

Capital in this study illustrates the use of consumption of fixed capital stock in agricultural sector.

Land

Land under study illustrates land use in kilometre for agricultural purposes.

3.6 Trade openness variables

The most essential variables of this study will encompass variables that affect the technical efficiency equation. According to this study, three different dimensions of trade openness where tested. Trade to GDP ratio, import penetration and export intensity have values that range from 0 to 1 illustrating a more open to a less open trade system respectively. More so trade openness can have both negative and positive figures.

Trade to GDP ratio

Trade to GDP ratio is a parameter for calculating trade openness that's computed as $X+M/GDP$. It measures how open a nation is and illustrates how foreign markets affect domestic producers.

Import penetration

Import penetration is yet another measure of trade liberalisation parameter computed as M/GDP .

Export intensity

Export intensity explains the ratio of exports to GDP as a method of evaluating trade liberalisation to export quantities.

3.7 Diagnostic tests

3.7.1 Multicollinearity

Multi-collinearity occurs between two or more independent variables that has high correlation. The statistical inferences which are made about the data may not be reliable if there is a certain type of disturbance in the data obtained of the variable under review. Multi collinearity will occur when dummy variables studied are incorrect and when there exists repetition of interrelated variables. When multi collinearity occurs, redundancy of redundancy of information will occur. This study will detect multi collinearity through calculating correlation of coefficients. If the calculated r value assumes perfect Multicollinearity hence one variable must be eliminated from the study.



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Chapter 4

4.0 RESULTS AND DISCUSSIONS

4.1 Introduction

This section explains the findings of the study as per objective stated earlier. The results are stated as conferring to the models that are stated in the chapter 3. Analysis of the research findings will be done in detail and a synthesis of results will be made.

4.2 Descriptive Statistics

Descriptive statistics is used to interpret and summarise data into meaningful contexts. Furthermore it puts into context complicated and large quantities of quantitative data. The results of this study are illustrated in the form logarithms meaning outcome will be explained in the form of elasticities.

Variable	Unit	Mean	Standard Deviation	Minimum	Maximum
Labour	Index	12.8755	0.4133662	12.35182	13.74514
Capital	Index	19.1224	0.6117212	18.41214	20.45622
Pesticides	Index	8.071934	0.3012756	7.41698	8.817742
Land	Index	11.90076	0.0989228	11.73206	12.01067
Herbicides	Index	6.810016	0.2101013	6.308845	7.234177

Table 2

As shown by the table above, capital and labour has the highest variability as opposed to the other variables. Land and herbicides have a lower variability with the following figures respectively; 0.0989228 and 0.2101013. The variable with the highest mean among those stated earlier is capital and labour. This illustrates that these two variables have a greater contribution to output. Further analysis of descriptive statistics illustrates that the distribution followed by these variables is a negatively skewed distribution as illustrating the existence of ascending skewness values as exemplified by the table below. Due to the fact that this distribution is not normal hence the values of Kurtosis on this study are not of paramount significance.

Variable	Variance	Skewness	Kurtosis
Land	0.0097857	-0.386249	1.550979
Capital	0.3742029	0.8679738	2.452208
Labour	0.1708716	0.8821804	2.319721
Herbicides	0.0441426	0.1637136	3.453649
Pesticides	0.090767	0.2832306	3.84974

Table 3

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4.3 Objectives and corresponding results

4.3.1 Objective 1

- i. To estimate the level of technical efficiency in Zimbabwe Agricultural Sector?

Findings on the Objective

output	Coefficient	Standard error	Z	P>{z}	95% Conf lower	95% conf Higher
Labour	0.1025943	0.123444	0.83	0.414	-0.1527691	0.3579578
Land	0.4541397	0.3414147	1.33	0.197	-.02521304	1.16041
Capital	0.0465755	0.0296828	1.57	0.130	-0.0148281	0.107979
Pesticides	-0.0511901	0.1178985	-0.43	0.668	-0.2950818	0.1927016
Herbicides	0.0895024	0.1893954	0.47	0.641	-0.3022917	0.4812966
Cons	8.831046	5.874303	1.50	0.146	-3.320875	20.98297

Likelihood-ratio test of $\sigma_u=0$: Prob>=chibar = 0. 3746

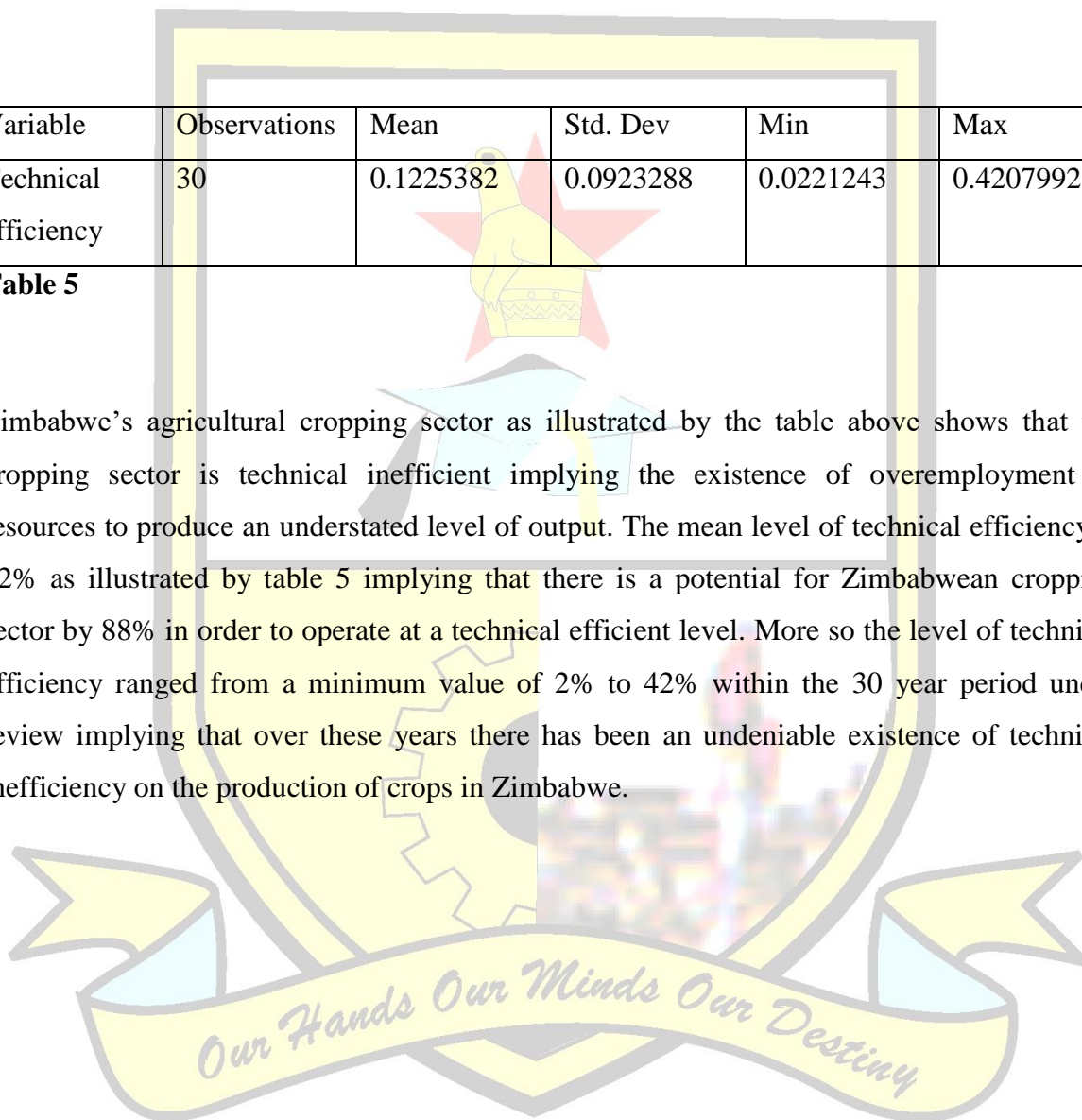
Table 4

The table above is a basic description of values obtained after estimating production function of all the variables involved in the production process of the model against the dependent variable of output. As given above, we must reject the hypothesis that states that $u=0$ because the $\text{Prob} \geq \chi^2 > 10\%$ and accept alternative hypothesis $u \neq 0$ and therefore conclude that the data analyses portrays the presence of technical inefficiencies among the variables under review.

Variable	Observations	Mean	Std. Dev	Min	Max
Technical efficiency	30	0.1225382	0.0923288	0.0221243	0.4207992

Table 5

Zimbabwe's agricultural cropping sector as illustrated by the table above shows that the cropping sector is technical inefficient implying the existence of overemployment of resources to produce an understated level of output. The mean level of technical efficiency is 12% as illustrated by table 5 implying that there is a potential for Zimbabwean cropping sector by 88% in order to operate at a technical efficient level. More so the level of technical efficiency ranged from a minimum value of 2% to 42% within the 30 year period under review implying that over these years there has been an undeniable existence of technical inefficiency on the production of crops in Zimbabwe.



4.3.2 Objective 2

- ii. To assess whether trade liberalisation affects technical efficiency.

Findings of the model

Output	Stochastic frontier parameters		Production function equation	
	Parameter	SE(standard error)	Z-value	P(Z)>z
Year	-63.09425	26.1846	-2.41	0.016
Labour	-0.0060983	0.1239266	-0.05	0.961
Land	2.526695	0.8864329	2.85	0.004
Capital	0.0641729	0.0223942	2.87	0.004
Pesticides	0.1304836	0.0884289	1.48	0.140
Herbicides	-0.3795269	0.152467	-2.49	0.013
Trade openness variables				
Intercept	0.0442209	0.045148	0.98	0.336
X+M/GDP	0.1161921	0.0856707	1.36	0.186

Table 6

In this study, trade openness will be the first model to be observed and interpreted. Trade openness / liberalisation as stated above is the ratio of the sum of exports and imports of agriculturally produced output divided by GDP. A negative but significant coefficient associated with the time (year) suggests a technical change in the agricultural sector during the period under consideration led to a decrease in output quantity index. Based on the parameter coefficient, a change from one year to the next would lead to a decrease in the output index. In cognisance with the results obtained by Miljickovic and Shaik (2010), land, capital and herbicides were the major variables that caused an increase in output among all the other factors of production considered in the study assuming all other inputs excluded

from the study are held constant. An increase in cropping land, capital and herbicides by 10% will lead to a 25.26 % (25.26695), 0.6% (0.064) and 3.79% (0.379) increases in aggregate output respectively. However results illustrate that land is the most significant variable that leads to the greatest proportion increase in output.

Use of SFA to estimate the log likelihoodness of efficiency variables illustrated that when trade liberalisation policies are increased by 10% therefore output will increase by 11%. However this statement is inconclusive. This is so because the actual probability value of trade openness is greater than 10% being 18.6% implying that we reject the null hypothesis of $u=0$ and accept the alternative hypothesis and conclude that trade openness will not cause increases in output levels by 11%. This model therefore illustrates that there is no impact or relationship between trade to GDP ratio and technical efficiency. The lack of conclusive results on the effects of technical efficiency and trade openness ratio will lead to further analysis of effects of trade openness using both import penetration and export intensity to technical efficiency separately.

Output	Stochastic frontier parameters		Production function equation	
	Parameter	SE(standard error)	Z-value	P(Z)>z
Year	-51,16404	25.71957	-1.99	0.047
Labour	-0.0443611	0.1138758	-0.39	0.697
Land	2.081928	0.8802721	2.37	0.018
Capital	0.0656702	0.0197319	3.33	0.001
Pesticides	0.1385721	0.0841876	1.65	0.100
Herbicides	-0.420123	0.1533074	-2.74	0.006
Trade openness variables				
Intercept				

	0.09733858	0.0465128	2.09	0.046
M/GDP	-0.4930367	0.2231648	-2.21	0.036
X/GDP	0.3950076	0.1227399	3.22	0.003

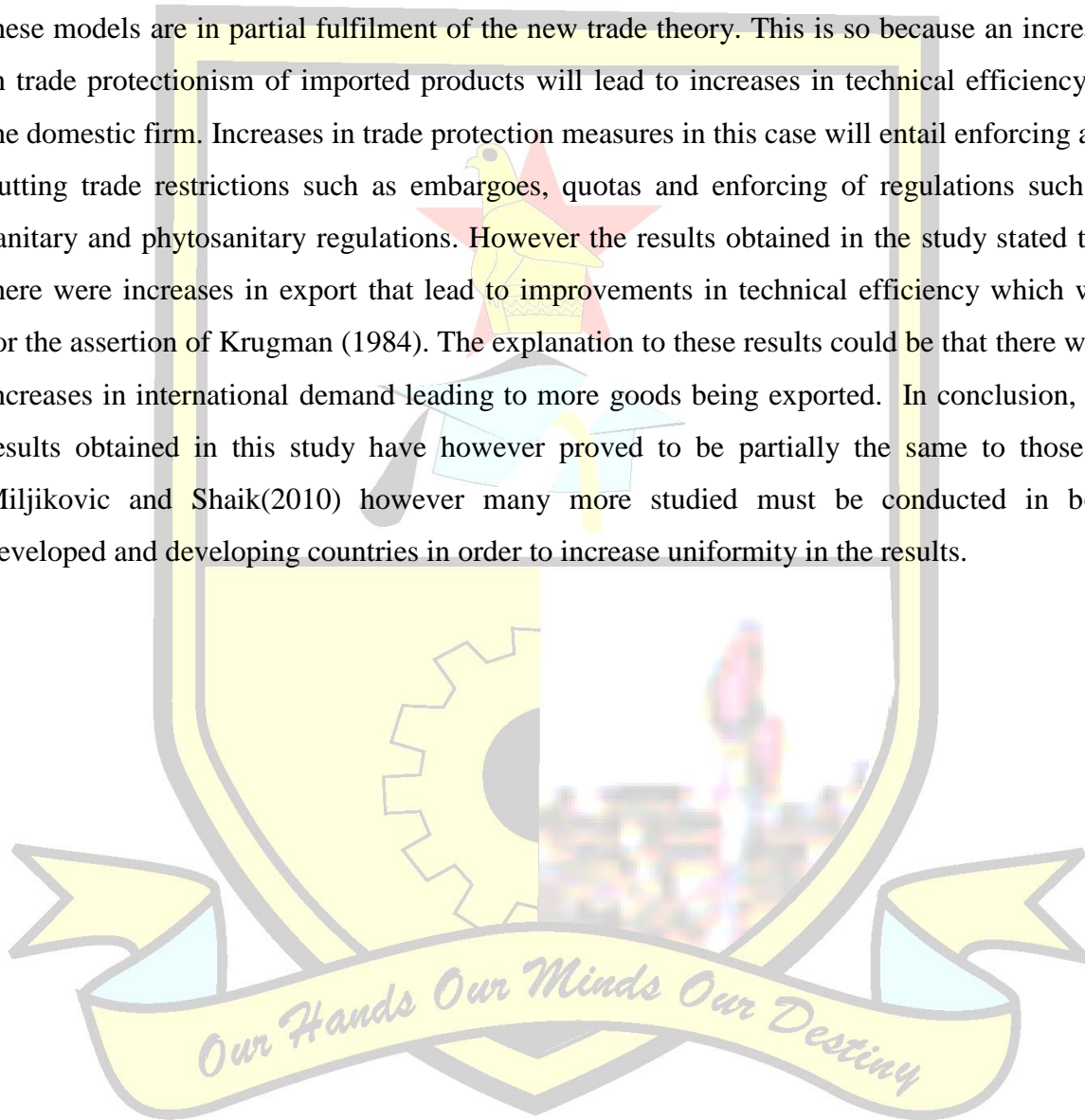
Table 7

Trade policies are commonly put in place for the benefit of the economy and citizens. If the implementation of trade free policies yields negative to no results, there is need for policy makers to regroup and create policies that will promote economic development. The above table illustrates two measures of trade openness that are divided into two groups; import penetration (imports divided by GDP) and export intensity (exports divided by GDP). This measure is essential as it highlights the impact of exports and imports on technical efficiency as individual components. From the previous model, the factor inputs are significantly different. The elasticity of the PPF is slightly less responsive on the second model. This is so because a 10% increase in land will lead to a 20.8% increase in total yields. The second model illustrates a similar set of variables that are significant to causing increases in output levels; land, capital and herbicides.

The biggest difference between the first model and the second is however the trade openness equation. A detailed analysis of technical efficiency equation illustrates that the probability of chi bar of export intensity is less than 10% at 0.03% illustrating that export intensity as a trade liberalisation strategy has a positive effect on technical efficiency however the effect is of a smaller magnitude. On the other hand import penetration similarly affects technical efficiency however in a different way. A decrease in trade openness on imported commodities will lead to an increase in technical efficiency. However an increase in import penetration has a negative bearing on technical efficiency change. Import to GDP ratio move in an inverse direction with technical efficiency. More so the probability of chi bar on import penetration is less than 10 illustrating that we reject null hypothesis $u=0$ and conclude that decreases in import trade openness policies will yields a positive effect on technical efficiency. A 10% decrease in import to GDP ratio will yield a 49% increase in technical efficiency.

4.4 CONCLUSION

New trade theory as according to Krugman states that increasing protectionism on imported goods will allow firms to increase domestic production and sales and therefore reduce marginal costs. This scenario will facilitate domestic agricultural firms to be able to sell even in international markets and hence increase the number of exports. The results as according to these models are in partial fulfilment of the new trade theory. This is so because an increase in trade protectionism of imported products will lead to increases in technical efficiency of the domestic firm. Increases in trade protection measures in this case will entail enforcing and putting trade restrictions such as embargoes, quotas and enforcing of regulations such as sanitary and phytosanitary regulations. However the results obtained in the study stated that there were increases in export that lead to improvements in technical efficiency which was for the assertion of Krugman (1984). The explanation to these results could be that there were increases in international demand leading to more goods being exported. In conclusion, the results obtained in this study have however proved to be partially the same to those of Miljickovic and Shaik(2010) however many more studied must be conducted in both developed and developing countries in order to increase uniformity in the results.



Chapter 5

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section will explain the conclusion of the study, recommendations and areas of further study as from the results obtained in this study.

5.2 Conclusion

The results of this study designate that there are no effects that exist between trade openness and technical efficiency as a whole. Meaning that regardless of an increase in trade openness, given the following variables; labour, capital, land and agrochemical variables, over the years 1985-2014, no changes to technical efficiency were noted. However a further break down of trade openness to import penetration and export intensity further led to realisation of slightly different results. Export intensity has a positive effect to technical efficiency implying that increases in export penetration will lead to slight improvements on technical efficiency. However import penetration yielded a complex relationship. Increases in trade protectionism will lead to increases in technical efficiency values. A decrease in the level of trade openness to imported commodities will lead to an increase in technical efficiency. The results acquired however could be in tandem with other past researches however there still exists lack of uniformity in this issue as some realise a negative, some positive relationship between technical efficiency and trade liberalisation.

5.3 Recommendations

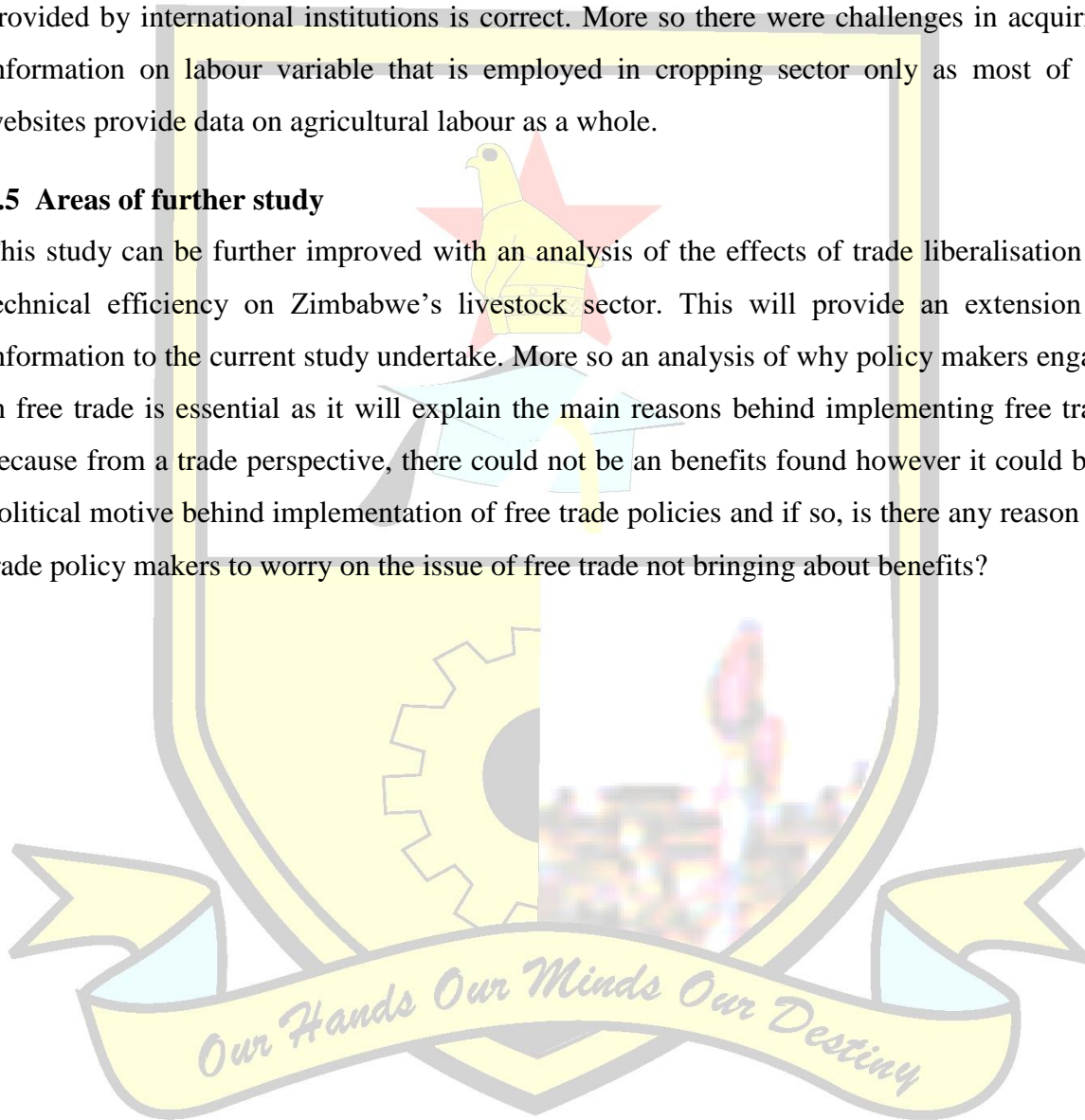
Due to the lack of consensus of results that exist on the top under review, I recommend a further analysis of this topic under review in order to increase the number of articles that exist of the relationship between technical efficiency and trade liberalisation. More so a recommendation of further on studied on import penetration and export intensity must be undertaken on other sectors in order to discover the effects of the two parameters on technical efficiency.

5.4 Limitations of the study

The main limitation of the study was the acquisition of data related to production function. Most websites had unlimited data regarding to variables that were reviewed in the study. Initially the study was aimed at doing a 50 year analysis however due to the scarcity of data the number of years were reduced. The other limitation was that since most of the data was not acquired domestically, there are increases in data biasness's because not all information provided by international institutions is correct. More so there were challenges in acquiring information on labour variable that is employed in cropping sector only as most of the websites provide data on agricultural labour as a whole.

5.5 Areas of further study

This study can be further improved with an analysis of the effects of trade liberalisation on technical efficiency on Zimbabwe's livestock sector. This will provide an extension of information to the current study undertake. More so an analysis of why policy makers engage in free trade is essential as it will explain the main reasons behind implementing free trade because from a trade perspective, there could not be an benefits found however it could be a political motive behind implementation of free trade policies and if so, is there any reason for trade policy makers to worry on the issue of free trade not bringing about benefits?



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