ECONOMETRIC ESTIMATION OF THE DEMAND FOR MEAT IN NAMIBIA

BY HILTRUDIS N. ANDJAMBA

Submitted in accordance with the requirements for the degree

MAGISTER SCIENTIAE AGRICULTURAE

in the

PROMOTER: DR A. GEYER

CO-PROMOTER: DR A.A. OGUNDEJI

FEBRUARY 2017

FACULTY OF NATURAL AND AGRICULTURAL SCIENCES

DEPARTMENT OF AGRICULTURAL ECONOMICS

UNIVERSITY OF THE FREE STATE

BLOEMFONTEIN

DECLARATION

I, Hiltrudis Nahako Andjamba, hereby declare that:

- This dissertation submitted for the degree of *Magister Scientiae Agriculturae* in the Faculty of Natural and Agricultural Sciences, Department of Agricultural Economics at the University of the Free State is my own independent work, and has not previously been submitted by me to any other university.

- That I am aware that the copyright of the thesis is vested in the University of the Free State.

- That all royalties as regards intellectual property that was developed during the course of and/or in connection with the study at the University of the Free State, will accrue to the University of the Free State.

______________________________ ______________________________

Hiltrudis N. Andjamba Date

BLOEMFONTEIN

DEDICATION

"Progress has less to do with speed and more to do with direction"

– Unknown Author

This dissertation is dedicated to my husband, Andrew Shikongo, and children,

Alexander Obinna S. Obi-Osueke and Rachel S. Negumbo,

to whom I will always be grateful for this lifetime opportunity.

ACKNOWLEDGEMENTS

First and foremost, I want to thank the Almighty God who granted me undeservingly the opportunity, strengths, gratuity, insight, guidance, calmness and perseverance, by His Wisdom, to complete this research. I would also like to thank my family, study supervisors, colleagues and friends for their unwavering support, motivation, encouragement and the sacrifices they made for the duration of this thesis.

In a nutshell, I would like to express my sincere gratitude towards the following people and organisations for their contribution during this study:

- Dr Antonie Geyer, my supervisor, for the significant contributions and for his willingness to assist and listen in any way possible during the duration of this study. I could not thank you enough.

- Dr Abiodun Ogundeji, my co-supervisor, for his dedication toward ensuring that I completed this study and for not giving up on me, even when I myself felt I could not carry on. Thank you Dr Ogundeji, God Bless.

- My immediate supervisor, Mr IVIN. Nathinge, and Mr Mesag Mulunga, for affording me an opportunity to carry out my study in my office, even though the work was calling. Thank you.

- My colleague, classmate and “Makula”, Mr Matheus Ndjodhi, for studying together and always knocking on my door to encourage me and remind me that giving up is not an option. What would have been the outcome if you had not insisted that I should finish? I will always be grateful for that.

- My colleagues, Greece Thikusho, Hileni Nehemia, Albertina Elungu, Aino Shapaka and many more, the list is infinite. Thank you very much guys for your unwavering support.

- The entire Ministry of Agriculture, Water and Forestry, Namibia.

The views expressed in this thesis are not necessarily that of the Ministry of Agriculture, Water and Forestry.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ACP	African, Caribbean and Pacific
AIDS	Almost Ideal Demand System
ANOVA	Analysis of variance
EFTA	European Free Trade Area
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
ISO	International Organization for Standardization
LA/ AIDS	Linearized Approximation Almost Ideal Demand System
LES	Linear Expenditure Model
LR	Likelihood ratio
MCOOL	Mandatory country-of-origin labelling
MRS	Marginal rate of substitution
NPC	National Planning Commission of Namibia
NSA	The Namibia Statistics Agency
NVCF	North of Veterinary Condon Fence
OLS	Ordinary Least Squares
RSURE	Restricted Seemingly Unrelated Regression Estimate

SACU	Southern African Customs Union
SADC	Southern Africa Development Community
SUR	Seemingly Unrelated Regression
SURE	Seemingly Unrelated Regression Estimate
SVCF	South of Veterinary Condon Fence
USA	Unites States of America
USD	United States dollar
WTO	World Trade Organization

ABSTRACT

Econometric Estimation of the Demand for Meat in Namibia

By

Hiltrudis Nahako Andjamba-Shikongo

Degree: MSc Agric

Department: Agricultural Economics

Supervisor: Dr A. Geyer

Co-supervisor: Dr A.A. Ogundeji

Abstract

This study estimated the Rotterdam and the LA/AIDS model with the reason to determine an appropriate model for Namibian meat products. The data used in the study are prices and quantity demanded for Namibian meat products, such as beef, mutton, pork and chicken, for the period from January 2001 to December 2013. The data were analysed using Eview 7 by Seemingly Unrelated Regression Estimation (RSURE) method that produces four separate equations, namely beef, mutton, pork and chicken equations.

The data used in predicting both models were first tested to determine whether they are stationary. As a result, the data employed were integrated of order one (I(1)). The parameters of the models were estimated using the RSURE method. The econometric restrictions, such as homogeneity and asymmetry, were imposed during the estimation of both the models. Because the mutton equation was dropped during the regression process, the adding-up restriction was used to recover the parameters for the mutton in both the models.

As for the Rotterdam model, the system R^2 for the Rotterdam modes is 19.1 per cent. All expenditure coefficients are positive, which is in line with the *a priori* expectations. With the exception of chicken, the expenditure coefficients for beef (0.007), pork (0.014 and mutton (0.027) are very close to zero, implying that these products are normal goods. The beef share equation further indicates that an increase in the price of chicken (-0.004), pork (-0.003) and mutton (-0.007) reduces their share in the budget because consumers prefer to spend their income on beef. Unlike the Rotterdam model, all three sets of restrictions in the LA/AIDS model were satisfied during the regression. Nine out of twelve estimated parameters are statistically significant at one per cent level of confidence. One is significant at ten per cent level of significance, while only two parameters are insignificant. The system R^2 (39.4) for the LA/AIDS model is higher than that of the Rotterdam model.

The estimated expenditure elasticities for beef, chicken, pork and mutton are 0.60, 1.46, 0.41 and 1.06, respectively. Beef and pork are relatively inelastic, while chicken is more elastic than mutton is. The expenditure elasticity result for the LA/AIDS model implies that chicken and mutton are regarded as luxury products, while beef and pork are normal goods in the Namibian purchasing basket. Based on the performance of the two models on Namibian meat data, the LA/AIDS model, compared with the Rotterdam model, performed better in terms of the model's ability to meet the econometric restrictions of homogeneity and asymmetry, the highest adjusted R^2, and the results that are in conformity with the *a priori* expectation in terms of compensated own-price and cross-price elasticities. It is therefore concluded that the LA/AIDS models are a better fit for the Namibian meat data.

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Meat is one of the most vital agricultural products in the world and contributes most to both the total gross value of agricultural commodities and the value-adding system of other commodities and products (Taljaard, 2003). Although the consumption of meat in the world differs, depending on economic conditions, tastes, health concerns, cultural beliefs, religious preferences, and economic condition amongst others factors, the world production of meat has been increasing as a result of meat being an important source of calories and protein in the diet. A study by Delgado, Rosegrant, Steinfeld, Ehui, and Courbois (1999) estimated that the world meat production increased by 1.4 % to 308.2 million tonnes in 2002 although meat and meat product prices have not changed. In addition, Delgado *et al.*, (1999) predicted that meat consumption in the developing countries is expected to increase with an average of more than 36 kilograms per person per year in 2020. Delgado *et al.*, (1999) further reported that the average consumption of meat in developing countries is expected to double that of the 1980s. The industrial countries on the other hand are estimated to consume an average of nearly 90 kg of meat per person per year in 2020 (Delgado *et al.*, (1999). The main reasons for these increases in meat production and meat consumption are increasing world population, improving technologies, and increasing consumer incomes, among other factors (Osho and Asghar, 2005).

Despite the general improvement in food production technologies and consumer incomes, the world per capita meat consumption is lower in the less-developed countries of the world. According to FAO (2013), the overall consumption of white meat, specifically poultry and pork, increased dramatically between 1990 and 2009. Beef consumption, on the other hand, decreased during the same period. There is evidence of the increasing share of animal products in consumer diets in both the developing and industrial countries of the world (FAO 2013).

Owing to the higher demand for food and food products, and the need to understand the market, several scholars have embarked on studies on consumer behaviour to enable them to understand and predict consumers' buying behaviours and the choices they make in the marketplace. Earlier studies started and worked with a single equation until several decades later when consumer studies were motivated toward adopting a system-wide approach (Lee, Brown & Seale, 1994). Richard Stone (1954) was the first to develop a system of demand equations, called the Linear Expenditure System (LES). Many other models were proposed but those that gained extended use are the Rotterdam model by Theil (1965) and a translog model by Christensen, Jorgenson & Lau (1975). According to Deaton & Muellbauer (1980), the single equations are primarily focused on estimating the elasticities and pay minimum attention to the consumer theory, while a system of demand equations approach confirm whether a demand system approach is in consistent with the consumer theory.

Generally, many system-wide approaches can be used in estimating demand for products, especially in the field of agriculture. The most popular and widely used methods are:

a) The Linear Expenditure System (LES) developed by Stone (1954).

b) The Rotterdam model developed by Theil (1965) and later expanded by Barter (1969).

c) The Almost Ideal Demand System (AIDS) model developed by Deaton & Muellbauer, (1980).

d) The direct and indirect translog function by Jorgenson and Lau (1975).

e) The Generalized Almost Ideal Demand System proposed by Bollino (1980).

Although these models aim at analysing consumer behaviours, it is of practical importance that an appropriate model is chosen that fits well with the specific data and that further predicts meaningful and statistically adequate estimates.

According to the Namibian Agricultural Policy (2015), the meat industry forms the backbone of the agricultural sector, contributing about 80 % to the agricultural Gross Domestic Product (GDP). The Namibian Agricultural Policy (2015) further reported that the agricultural sector accounted for 3.7 % to GDP in 2014, of which 60 % is attributed to the livestock sub-sector. According to the World Bank (2012), the country has a comparative advantage in terms of livestock production, but does export and import meat and meat products. The World Bank (2012) further stated that the high-value-priced meat cuts of beef were being exported to European consumers, while lower-priced meat is imported in the country, for domestic consumption and/or as inputs for processing of meat products.

Since Namibia gained independence in 1990, a considerable number of structural changes have occurred (Strydom & Müseler, 1998). Amongst these are a) change in income distribution, b) increase in population, c) reduction in tariffs due to trade agreements that Namibia has signed with other countries, as well as d) consumer preferences. Strydom & Müseler (1998), further reported that these factors could impact on the substitution effects of the consumers and hence affect the demand aspect.

Meanwhile, Taljaard (2003) has indicated that the liberalisation of international markets through trade agreements has a significant impact on local products in domestic markets. One of the effects of liberalisation is that domestic product prices will be closely linked to international product prices. Taljaard (2003) further stated that the effects of these trends are directly linked to changes in the total demand for local products, specifically prices, and hence the substitution between different meat products (Taljaard, 2003). In addition, a study by Strydom & Müseler (1998) cautioned about the negative impact the world price instability in the global economy would have on the consumption of Namibia's primary products, specifically referring to the demand for meat in the domestic market.

Because meat trading in Namibia has been concentrated on export markets, especially to South Africa and the European Union, the majority of studies done in Namibia with regard to demand for meat were either export oriented. Examples of such studies are those by Dakwa (2007), Strydom & Müseler, (1998), Luis, Chris, Rocky, and Kishore (undated), Mushendami, Biwa, and Gaomab II (2006), Overseas Development Institute, (May 2007) and Schutz (2009) amongst others, although these were mostly focused on beef and mutton production and exports. In addition, a study by Musaba & Namukwambi (2011) was focused on purchasing of fish products in Namibia. To date, there is no known study conducted that has estimated the demand system for meat in Namibia. In addition, there is no known study conducted that has compared different model specifications for meat consumption pattern in Namibia. The objective of this study is to analyse meat demand in Namibia for the period from January 2001 to December 2013. Meat products included in the survey are beef, chicken, mutton and pork.

These meat products play a significant role in the diets of consumers and directly or indirectly contribute significantly to the social economics of the people of Namibian. The understanding of meat demand and consumption patterns is vital for policymaking purposes and economic strategic planning.

1.2 PROBLEM STATEMENT AND NEED FOR THE STUDY

Monitoring a specific commodity market is vital to all the stakeholders involved in informed economic prediction and effective policy decision-making. For many decades, the proper measurement and interpretation, using systems of equations methods, of the responsiveness of demand and supply for meat products attributable to change in meat prices, consumer incomes and consumer preferences has been an important aspect in many countries. A study by Hupková, Bielik, and Turčeková (2005) on the structural change in beef demand in Slovakia for the period between 1993 and 2006 showed that price and consumer income factors accounted for a percentage change in explaining the changes in meat consumption patterns in that country.

According to Scriven, (2014), global trade has resulted in creation of free trade agreements and economic union. This factor is also true when it comes to Namibian trade. Scriven (2014) further reported that regional integration provides consumers with more choices, gives better access to a wider variety of quality products and services, decreased prices and generates income. Before and after independence, Namibia engaged in international and regional economic integrations. Amongst those are the Southern African Customs Union (SACU) and Southern African Community Development (SADC). In addition to these integrations, Namibia has made tariff concession commitments to the World Trade Organization as well as through trade agreement negotiations with the European Union (EU), European Free Trade Association (EFTA) and the Common Market of the Southern Cone (MERCOSUR), to mention but a few. As member of SACU, Namibia is currently engaging on tripartite trade negotiation with EAC and COMESA as well as the Continental Free Trade Area. The outcome of these negotiations will have an impact on demand for products in the domestic markets.

The food expenditure share takes up a relatively significant proportion of total expenditure, and therefore studying domestic demand for goods, and specifically food, is of vital importance for economic and social planning. The expenditure share for any good or service is highly affected by the price of the product, together with amongst other things such as health, social and religious beliefs, and prices of other related, similar, complementing or unrelated products. Similarly, studying consumers' reactions to changes in factors or variables that affect demand for a certain commodity is of utmost importance and requires ascertaining good elasticity estimates through the estimation of a model that is correctly specified and follows economic theories.

As stated earlier, no studies have been conducted in Namibia, specifically with regard to estimating the demand for Namibian meat products, using a system of equations approach. To date, most studies carried out with regard to demand for meat were mostly export oriented.

Based on the above facts, studies on meat demand could make a valued impact towards improving the accuracy of demand change estimations. Similarly, demand models are vital instrument or guides in developing and analysing marketing and trade policies around the world. This has, therefore, created an opportunity for a study that estimates a Namibian demand model that could be used to assess the demand, and calculate the elasticities, for meat products in Namibia.

1.3 OBJECTIVES

The **main objective** of this study is to estimate and explain the variation of the meat demand in Namibia.

The specific objectives of the study are as follows:

- To estimate and compare the Almost Ideal Demand System (AIDS) and the Rotterdam model using Namibian time series data for the period from January 2001 to June 2014.
- To assess the theoretical demand restrictions for the two models and select the model that fits best to the Namibian meat demand
- To calculate the demand elasticity for each meat equation with respect to own price, prices of other meat, and other possible demand factors.
- To provide practical results that can be used as a scientific basis for policy makers to design relevant policies for the meat industry in Namibia.

1.4 HYPOTHESES TESTING

Based on the objectives of the study, two hypotheses can be tested:

1. The Linear Approximate Almost Ideal Demand System (LA/AIDS) model is the best model for estimating meat demand in Namibia, compared to the Rotterdam model;

2. The Linear Approximate Almost Ideal Demand System (LA/AIDS) model is the best linear model for estimating meat demand elasticities.

1.5 SIGNIFICANCE OF THE STUDY

The results of this study are of substantial importance to the policy makers, producers and role players in the meat industry. This study will portray the real situation of the behaviour of consumers, based on the changes in prices of individual meat products. The results will be of assistance to the government, the private sector and other role players in the meat industry when determining economic policies and strategies, especially in making production decisions and in supporting the increasing demand for meat and meat products in the country. The elasticity estimates of individual meat products will assist with attaining an understanding of the interpretation of the substitution effects of meat products in the domestic market. Additionally, this study, being one of the few designed to make estimates based on the complete demand system, will bridge the knowledge gap in meat consumption in Namibia. Therefore, studies on the demand for products, specifically for meat products on a regular basis, are vital for the country's economic development and strategic policy development.

1.6 LIMITATION OF THE STUDY

This study was hampered by incomplete statistical data, especially times series data, which are not readily available in Namibia. The main reason for this is that statistics in Namibia are scattered and managed by different institutions. For example, data on the volume of meat production and producers' prices for beef, mutton, and in recent years pork, are managed by the Meat Board of Namibia, while the import and export data are now managed by the Namibian Statistical Agency, which was transformed into an agency of government in 2014 to manage national data. The available time series data were for the period from 2000 when the country gained its independence. The use of yearly data was made impossible because of the required number of observations needed for this type of study. This has, therefore, resulted in the use of monthly data to increase the number of observations.

1.7 THE STUDY OUTLINE

The rest of the study is organised as follows:

- Chapter 1 gives the background information of the importance of conducting a demand study for the four meat products in Namibia, together with a description of the objectives and limitation of the study.

- Chapter 2 gives a literature review and elaborates on the methods used by other authors for the selection of the best-fit model for specific areas of studies. Furthermore, the chapter will also describe relevant research findings of those studies.

- Chapter 3 will give an overview of the study area.

- Chapter 4 provides a synopsis of the general research methodology for the study and presents the model designing and procedures for hypothesis testing. The structural specification of the absolute AIDS, LA/AIDS and Rotterdam model, as well as data specifications, are described.

- Chapter 5 reports on the results of the study. The chapter starts with a short introduction, followed by testing for restrictions on the data used in estimating both the Rotterdam and the LA/AIDS models, before presenting the empirical estimation and interpretation of the results. The findings of the study will be shown in the form of tables and figures, and arguments for and against the findings, based on literature review, will be presented.

- Chapter 6 gives the conclusion as derived from the preceding chapter, as well as recommendations made to overcome the limitations of the study. The empirical results for both the LA/AIDS and the Rotterdam models will be compared and a conclusion on which model fits best with Namibian meat data is made. Further recommendations for further studies that will benefit the country are also presented.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides an assessment of the relevant literature with regard to economic demand theory, based on previous red meat studies in developed and developing countries that are of interest to the objectives of this study. Consumer behaviour is defined as a study of when, why, how, and where people do or do not buy a product (Reynolds, 2005). Reynolds (2005) further stressed the point that consumer behaviour studies are aimed at giving an understanding of a buyer's decision-making process, both as an individual or in groups, by blending in all the elements of sociology, psychology and economics together to interpret the outcome.

For the last few decades, research in applied economics has been focused on the use of single equation modelling to predict consumer demands. Although the characteristics of the single equation model are used for estimating elasticities, little attention has been focused on the consumption theory (Deaton & Muellbauer, 1980). However, in the last few decades, research in applied economics has shifted to estimating consumer demand using system-wide approaches. The system of equations modelling ensures that the demand model is in conformity with *a priori* expectations of the consumption theory, as demand functions are established by the theory of consumers' choice (Deaton & Muellbauer, 1980).

According to Griffith, I'Anson, Hill, Lubett, and Vere (2001), accurate economic forecasting as a result of consistent estimates of the responsiveness of the supply and demand for products, and in particular agricultural products, to prices and other factors is important for making policy decisions. Griffith *et al*. (2001) further argued that these estimates are useful for decision making by government departments, academics and research institutions.

Moreover, Hupková, Bielik, and Turčeková (2005) reported that estimating demand systems have been extensively used in developing policies. In addition, Hupková, *et al.* (2005) stated that the demand system has been used in forecasting the effects of intervention, specifically in the form of taxes or subsidies, and in a more recent trend, in predicting the impacts of deregulation. It is important to realise that monitoring a specific commodity market is a continuous process. With this understanding, the response of consumers to changes in product prices and availabilities of products attributable to changes in their external environment is necessary for reliable estimation. According to Hupková, *et al.* (2005), reliable estimates of the responsiveness of these factors are fundamental to economic forecasting, gauging the impacts of new production technologies or promotion campaigns and for effective policy decision-making. For example, the own-price elasticity of demand indicates the extent to which buyers determine their purchases after the price of a product rises or falls. Furthermore, these estimates are necessary for academics, government departments, and other stakeholders interested in monitoring the consumer behaviour in a certain product market.

Amongst the most well-known, system-wide models used by researchers in the field of applied economics, and in particular in agricultural economics, are an Almost Ideal Demand System (AIDS) model of Deaton & Muellbauer (1980) and the Rotterdam model by Barter (1964) and Theil (1975). According to Alston & Chalfant (1993), both the Rotterdam and the AIDS models gained prominent acceptability in research during the past decades. Alston & Chalfant (1993) further argued that the popularity of these two models is due to their flexible functional form; they appear very similar in structure, both are in conformity with the theory of demand, require identical data requirement, and are both linear in their parameters. Meanwhile, an advantage that both the AIDS and Rotterdam model share is that the two models permit theoretical restrictions to be tested statistically, rather than by imposing them directly on the functional form.

2.2 ALMOST IDEAL DEMAND SYSTEM (AIDS)

For the past thirty decades, the Almost Ideal Demand System (AIDS), developed by Angus Deaton and John Muellbauer in the late 1970s, has gained a reputable usage in demand estimation, particularly in agricultural economics. The AIDS model was seen as a breakthrough in the prediction of a consumer demand system. According to Alston & Chalfant (1993), within a short period after the AIDS model had been introduced, the AIDS model gained a considerable reputation and was broadly adopted by agricultural economists, to the point that it appeared to be the most popular of all demand systems. Alston & Chalfant (1993) further reported that between 1980 and 1991, the AIDS model was cited 237 times in the Social Science Citation Index. Alston & Chalfant (1993) indicated that twenty-three out of twenty-five papers in agricultural economics had selected the LA/AIDS version as the best model for estimating a consumer demand system.

Deaton & Muellbauer (1980) estimated the AIDS model, using annual post-war British data from 1954–1974. Deaton & Muellbauer (1980) used eight categories of non-durable products, comprising food, fuel, clothing, household services, transport, drinks and tobacco, communication services, and other foods and other services, to estimate demand for that period. The result of their study concluded that the AIDS model possesses most of the properties thought necessary in conversion demand analysis. Furthermore, Deaton & Muellbauer (1980) found that the model is capable of explaining a high proportion of the change in the commodity budget share.

Jung and Koo (2000) studied the demand for meat and fish product in Korea by comparing the Linear Approximate Almost Ideal Demand System (LA/AIDS) and the Rotterdam model to determine the model which fitted well with their data, using the three-stage least squares (3SLS) estimator to estimate the demand system. The study of Jung and Koo (2000) indicated that the LA/AIDS model fitted better with their data, compared with the Rotterdam model.

Muzayyanah, Maharjan & Lall (2011), in their study on choosing the appropriate model for Indonesian livestock products such as meat, milk and eggs, compared the results of the Almost Ideal Demand System (AIDS) and Rotterdam model to choose the appropriate model for those data. The result of that study indicated that for own-price elasticity, both models are suitable to represent Indonesian livestock products demand. However, when they tested for the goodness-of-fit (adjusted R^2) and forecasting accuracy (RMSE), the LA/AIDS model was found to fit well, as it produced the elasticities better than the Rotterdam model did. Dameus, Brorsen, Sukhdial and Richter (2002) used a Cox test with parametric bootstrap to select between the linearised First-Differentiate AIDS (FDAIDS), the AIDS model, and the Rotterdam model using US meat demand (beef, fish, pork, and chicken). Although the Rotterdam model was found to be the best fit for the data, the tests failed to reject the FDAIDS. Dameus *et al* (2002), further reported that the findings implied that the Cox test, with the parametric bootstrap, was not a true test for the AIDS model.

Eales & Unnevehr (1993) estimated the Almost Ideal Demand System model using United States data to compare the outcome of their study with that of Chen & Veeman (1991). The results of the study indicated that own-price elasticities for beef, pork and poultry were -0.77, -0.87 and -0.95, respectively. The Chen & Veeman (1991) study on United States meat demand yielded results that are closer to those produced in the Canadian data. When the results of those studies were compared, it was observed that own-price elasticity of meats and poultry are higher in the United States than those obtained in Canada. A similar study conducted by Eales (1996) using the both the differential ordinary and inverse Almost Ideal Demand System (AIDS) model to estimated elasticity for meat and poultry products in Canada. The results of the study indicated that own-price elasticity, in particular for beef and pork, were considerably lower in absolute value. Furthermore, the estimates form the AIDS estimates were in consistent with the responsiveness of demand.

Cranfield (2012) used Canadian quarterly data from 1998 to 2010 for beef, pork and chicken to estimate a quarterly, weakly separable, Quadratic Almost Ideal Demand System. The restrictions that would lead to the less flexible Almost Ideal Demand System were rejected at the five per cent level. The results of the Cranfield (2012) study indicated that the first stage model demand for the meat group was inelastic, with an own-price elasticity of -0.24. Furthermore, the conditional, uncompensated own-price elasticity of demand was -0.83, while the unconditional, uncompensated elasticity of demand for beef was -0.43.

Xu & Veema (1995) studied structural change specification and the choice of functional form to determine whether or not the each impact of the demand parameter would properly estimates the meat consumption in Canada. Xu & Veema (1995) applied a joint, non-nested testing of both the linearised almost ideal demand system (LA/AIDS) and the Rotterdam models. Two models are said to be non-nested if neither of the models can be obtained from the other, either by some limiting process or by the imposition of equality and/or inequality constraints on one of the model's parameters (Xu & Veema, 1995). Xu & Veema (1995) used a gradual transition specification to test the joint non-nesting, with and without structural change, using the linearised almost ideal demand system (LA/AIDS) and the Rotterdam models. The results of the study with regard to the test of model choice without structural change did not produce the expected results, while the test of the models with structural change showed that the gradual-transition almost ideal demand model is preferred over the gradual-transition Rotterdam model.

Paraguas & Kamil (2005) used Malaysian meat data for the period between 1961 and 2002 to compare meat demand in Malaysia, using both the LA/AIDS and the Rotterdam models. The study also tested whether the two models are non-nested. The meat products included in their study were beef, pork, poultry, and mutton. The findings of their study indicated that the Rotterdam model and the first difference LA/AIDS model are non-nested and have different dependent variables. The outcome of the tests revealed that both models were acceptable for the set of data used in the study. However, based on the goodness of fit and reliability of estimates, the first differenced LA/AIDS model gained superiority over the Rotterdam model. Further to that, the study indicated that the pork and poultry compensated own-price elasticity estimates from the Rotterdam model did not produce the expected signs, and according to Paraguas & Kamil (2005), this has rendered the estimates obtained from the Rotterdam model questionable.

Paraguas & Kamil (2005) analysed meat demand in Malaysia over the period 1961–2002 by comparing the AIDS and the Rotterdam model systems of demand equations, using a non-nested hypothesis test adapted from the compound model approach of Alston & Chalfan (1993). The outcome of their tests revealed that both models could not be rejected at any significant level. Therefore, Paraguas & Kamil (2005) further examined the two demand systems based on goodness-of-fit, accuracy in forecasting, and the elasticity behaviours of each of the demand systems. As a result, the first difference LA/AIDS model performed better than the Rotterdam model did and was found to be the best fit for the Malaysian demand data.

Barnett and Seck (2008) compared the Rotterdam, linearised AIDS and the PIGLOG (which is a full nonlinear AIDS) using a Monte Carlo technique to estimate a model that produces desirable results in terms of the ability of the model to recover the accurate elasticities of demand. The findings of their study did not, however, rule out either of the models. Barnett and Seck (2008) reported that both models performed fine when substitution among goods is low, and both yielded correct estimates of the elasticities. However, the AIDS model was found to perform better than the Rotterdam did when the substitution between goods was high, while the Rotterdam model performed better at predicting the elasticities when the accurate aggregation within weakly separable branches of a utility tree was used.

A study by Osho and Asghar (2005) used food demand data for the period between 1980 and 1999 to examine the responsiveness of demand for meat to variations in prices and incomes. The result of their study shows that demand for beef and other meat in Nigeria is very price elastic. The results further suggested that own prices and revenues are the predominant factors determining consumers' choice and meat consumption patterns in that country.

A study by Taljaard (2003) estimated a complete model system for meat demand in South Africa for the period from 1970 to 2001. The demand parameters were analysed using the Restricted Seemingly Unrelated Regression (RSUR) method to estimate the LA/AIDS model. The Taljaard (2003) study suggested that the expenditure elasticities for beef and mutton were higher than one, suggesting that these products can be regarded as luxury goods. Expenditure elasticity for pork, on the other hand, was found to be closer to one, while that for chicken was found to be relatively low at 0.53, implying that chicken is considered to be a necessary product in South Africa (Taljaard, 2003).

Following Deaton & Muellbauer (1980), and further confirmed by Alston and Chalfan (1993), Taljaard (2003) listed the features of the AIDS model as follows:

- The AIDS model is easy to estimate and interpret.
- The AIDS model can be easily interpreted in terms of economic model of consumer behaviour when estimated with aggregated (macroeconomic) or disaggregated (household survey) data.
- The model has a "flexible functional form" which is consistent with known household budget data.
- It can be derived from a specific cost function and therefore corresponds to a clear preference structure, which is convenient for welfare analysis.
- The Linear Approximate version of the Almost Ideal Demand System (LA/AIDS) is relatively easy to estimate and interpret.
- The Almost Ideal Demand System (AIDS) model gives an arbitrary first-order approximation to any demand system.
- The Almost Ideal Demand System (AIDS) satisfies the axioms of choice precisely.
- Homogeneity and symmetry restrictions depend only on the estimated parameters and are therefore easily tested and/or imposed.
- The Almost Ideal Demand System (AIDS) aggregates perfectly across consumers, without invoking parallel linear Engel curves.

None of other models (i.e. the Rotterdam or translog models), has all of the desirable properties simultaneously, as does the AIDS model.

Although the AIDS model has gained considerable popularity over past decades, the model has received some criticism. In his study of the application of the AIDS model on the general equilibrium, Pogany (1996) highlighted the problems that one can encounter when estimating the AIDS model. Amongst those is the issue that the AIDS model does not guarantee a global optimum. By this statement, Pogany (1996) implies that the AIDS model is not the most advantageous amongst other models. He further stated that the exogenous expenditure and the substitution elasticity of the AIDS model are said to cause departure from the theoretical functional form and that the use of policy requirements may weaken the AIDS model beyond the capacity to accommodate the change being tested. Because of this, Pogany (1996) warned that the model could be less predictable. Another criticism came from a study by Barnett & Kalonda-Kanyama (2003) to the effect that the linear-approximate AIDS model performed poorly at recovering the time-varying elasticities, and also badly approximated to the nonlinear AIDS model.

2.3 THE ROTTERDAM MODEL

As reported by Clemens & Gao (2007), the Rotterdam model was developed by Barten in 1964 and later expanded by Theil in 1965. In addition to the linear expenditure approach that was introduced by Stone in 1954, the introduction of the Rotterdam model has gained considerable popularity in the use of the system of equations modelling. According to Mountain (1988), the Rotterdam model was one of the first advanced systems of equations used in modelling consumer demand theory. Further to that, Mountain (1988) stated that the Rotterdam model could be used in modelling the entire substitution restriction matrix, which is linear in parameter and as such is easy to estimate, because the model's parameters can be simply linked to underlying theoretical constraints.

Anwar (2012, following Clement & Selvanathan, 1988) stated that the Rotterdam model has been used to perform estimable links with the economic theory of the consumer, and that the easiness in the application of the model has earned it considerable influence in the development of the system-wide approach. Barnett & Seck (2008) have also reported that the Rotterdam model was a breakthrough point in consumer analysis, offering many desirable features that were not available in the double log demand system and working lesser model. In addition, Barnett & Seck (2008) stated that the Rotterdam model is linear in parameter, can model the consumer substitution effect, is able to meet the theoretical restriction, and the parameters of the model can be easily estimated. Clements & Gao (2014) stated that the Rotterdam model is one of the leading examples of the demand system-wide approach. They further stated that the model could easily meet the economic theory of the consumer, and its simplicity in application made it popular amongst other system-wide approaches.

Mutondo & Henneberry (2006) used the Rotterdam model to estimate the demand for meat consumed in USA domestic market from different sources of origin (imports from New Zealand, Canada, Australia, and the Rest of the Word, as well as domestically produced meat). The study looked at beef, pork and poultry products. The data used for the study were quarterly data for the period between the first quarter of 1995 to the fourth quarter of 2005. The parameters of the Rotterdam model were estimated using the Seemingly Unrelated Regression method. The Rotterdam model results indicated that the own prices for beef imported from New Zealand and Australia were greater in absolute value than those for domestically produced beef were. The Mutondo & Henneberry (2006) study shows that domestic grain-fed beef and pork are preferred over imported beef in the USA market.

Piggott & Marsh (2001) investigated the effects of food safety on a weakly separable USA meat demand system for beef, pork and poultry, using both the Generalized Almost Ideal Demand System (GAIDS) and the Rotterdam model. The results of their study found by including food safety variables the that autocorrelation disappears in the GAIDS model indicating that food safety effects could last for a period of time, while the results from the Rotterdam model suggested that residuals form the model suffered from serial correlation even in the presence of the food safety variables which were included in the model. Furthermore, the Rotterdam model for the food safety indices was not significant for any indicated lag length. The Piggott & Marsh (2001) findings further indicated that the residuals from the GAIDS specification were not serially correlated. With regard to the total effect of own food safety elasticity, the GAIDS model was found to conform to the *a priori* expectations, while the Rotterdam model estimate was not in conformity.

Barnett & Kalonda-Kanyama(2003) assessed the abilities of the Rotterdam model and of the three versions of the Almost Ideal Demand System (AIDS) model to recover the time-varying elasticities for a correct demand system, while endeavouring to satisfy the theoretical regularity using the Monte Carlo simulations. The results of that study concluded that the Rotterdam model performs better than the linear approximate AIDS in terms of recovering the signs of all time-varying elasticities. Further to that, the Barnett & Kalonda-Kanyama (2003) study indicated that the Rotterdam model has the ability to track the paths of time-varying income elasticities. The linear-approximate AIDS model performs very poorly at recovering the time-varying elasticities, and was not a good approximation of the nonlinear AIDS in that study.

Taylor & Tonsor(2013) analysed the US mandatory country-of-origin labelling (MCOOL) law, which was developed in March 2009, to determine whether that law had affected the demand for covered meat products in the US after its implementation. The study used retail grocery store scanner data to estimate a Rotterdam demand model of meat products. The results of the Rotterdam model failed to detect a change in consumer meat demand after the introduction of MCOOL law. However, the study detected a welfare loss experienced by both producers and consumers as a result of the compliance costs incurred by meat processors.

Anwar, Aziz & Ali (2012) used the Rotterdam model to estimate the elasticities for nine Pakistani major commodities, using household integrated survey data for 2007–2008. The products covered in their study were mutton, chicken, milk, wheat, rice, onions, potatoes, apple and mangoes. The result of the study shows that all the estimated results were in conformity with the econometric theoretical expectation. For example, the own-prices elasticities for all food items were found to be negative, and their absolute values were also low, as was expected. All expenditure elasticities were positive and less than a unit, except for that of mutton. The expenditure elasticities suggested that the products being studied were normals, except for mutton, which is regarded as a luxury good in that country.

Notwithstanding the above positive views, the Rotterdam model came into criticism in the 1970s to the effect that the coefficients obtained from the model cannot be constant unless all expenditure elasticities are 1, and all own-price elasticities are -1. Saruga (1980) tested the constraints of the Rotterdam model, using Japanese family income and expenditure data for the period from 1953 to 1971. The commodities included in the Saruga (1980) study were housing, food, fuel, clothing, light and miscellaneous. The objective of that study was to investigate whether factors, other than income and price, influence expenditure. The result of the study failed to reject the hypothesis. Further to that, the econometric restriction tests, such as homogeneity and asymmetric constraint, were also rejected, which is in contradiction with the theoretical expectations of the consumer demand theory. Saruga (1980) attributed the outcome of the results to the period of observation, which was 20 years. As a result, the Rotterdam model was found not to be the best fit for the Japanese data.

2.4 ELASTICITIES OF DEMAND

Elasticity of demand refers to the ratio of percentage change in quantity demanded to a percentage change in price of a product. In a nutshell, price elasticities of demand are used in economics to show the responsiveness of the quantity demanded of a good or service to a percentage change in the price of that product or services, given the consumers' preferences, tastes, health, beliefs, culture, and religious practices, as well as popularity of the products, amongst other factors. The elasticity of demand further ascertains whether a product being studied is a normal, inferior or luxury good.

A product is referred to as a normal good if an increase in consumer income caused the demand for that product to increase while a decrease in consumer income cased the product's demand to decrease although the price of the product remains constant (Pettinger, 2011). An inferior good, on the other hand, is a product for which the demand decreases when consumer income increases. Luxury products are products that are not essential in a consumer's life, but the consumer will purchase that product to make life more pleasant, and are mostly associated with consumer wealth (Taniguchi & Chern, 2000).

Examples of studies that have used elasticities to determine whether a product is a normal, inferior or luxury good are those of Taniguchi & Chern (2000) and Adetunji & Rauf (2012). Taniguchi & Chern (2000) used cross-sectional survey data to estimate income elasticity and ascertain whether Japanese rice was a normal or inferior good in the Japanese diet. The Taniguchi & Chern (2000) study further sought to understand whether rice was a substitute or complement for meat and/or fish. The results of the AIDS model for that study indicated that income elasticity for rice did not exceed unit, and the rice consumed in Japan was found to be a normal good and was a mild complement to fresh meat and fish. The study further revealed that the Marshallian and Hicksian own-price elasticities for rice were highly elastic for all models employed in the study.

Adetunji & Rauf (2012) investigated household demand for meat in certain selected states in Southwest Nigeria. Adetunji & Rauf (2012) used a structured questionnaire to collect data from two hundred and forty households in the study area. The data were analysed using both the Descriptive Statistics method and the Almost Ideal Demand System (AIDS) Model to test the responsiveness of the quantity demand for beef, chicken, and mutton on the level of income for the respondents. The results of the Adetunji & Rauf (2012) study revealed that income levels of respondents and taste influenced the type of meat demanded. The study further revealed that beef, chicken and goat meat were found to be normal goods, while mutton and pork were found to be luxury goods for households in the south-west of Nigeria.

2.5 CONCLUSION

There are a number of studies conducted which compared the LA/AIDS and the Rotterdam demand model. Although both models have gained significant recognition in the area of econometrics, the majority of studies that this researcher came across, which compared the two models, selected the LA/AIDS models over the Rotterdam model as the best fit for the employed data. Examples of studies that selected the LA/AIDS model over the Rotterdam are those of Taljaard (2003), Muzayyanah, Maharjan & Lall (2011), Paraguas & Kamil (2005), and Jung and Koo (2000). The better performances of the LA/AIDS model, as stated in these studies, are attributed to its ability to observe a higher goodness of fit and reliability of estimates. On the other hand, studies by Barnett & Kalonda-Kanyama (2003), Anwar *et al*. (2012), and Taylor & Tonsor (2013) proved that the Rotterdam model could also be useful in predicting the demand for goods and services.

CHAPTER 3

THE OVERVIEW OF THE NAMIBIAN MEAT INDUSTRY

3.1 INTRODUCTION

The Namibian agricultural sector consists of two types of land ownership, namely the commercial sector producing meat for the export market, and the communal or subsistence farming sector producing mainly for household consumption, wealth and/or status. According to the Agricultural Policy (2015), the commercial sector covers around 41 % of the total land area and is predominantly in the livestock production area. According to the Meat Board of Namibia (2016), commercial farming, and in particular livestock farming, is considered to be the largest source of income for most Namibian households and is also the greatest source of private employment in the country, providing jobs to 25 000–30 000 workers. Farming in the communal area, on the other hand, where half of the population resides, is dependent mostly on livestock (cattle, sheep, goats and chickens) farming and rain-fed crop production. Although the national arable land accounts for only 1 % of the country landscape, about half of the Namibian workforce is employed in agriculture (Namibia Agricultural Policy, 2015).

Although the average agricultural contribution to the Gross Domestic Product (GDP) has been decreasing since 2000, the livestock contribution to GDP had been stable for the same period. Figure 3.1 below shows the contribution of agriculture to Namibian GDP between 2000 and 2015. The highest contribution of agriculture to GDP was 6.2 in 2005, followed by 6.1 % each in 2000 and 2006. The lowest contributions of agriculture were in 2013 and 2015, when agriculture contributed 1.9 %. Livestock contribution to agricultural GDP seemed to follow the same pattern as agriculture contributed to national GDP. The main agricultural products are beef, mutton, grapes and dates. Animal products, live animals and crops constitute 5 % of the total Namibia exports (Nathinge, 2011).

Namibia lacks value addition and agro-processing facilities, and as a result, most finished food products that are consumed in the country are imported or re-imported, especially from South Africa. Notwithstanding this, the agricultural sector remains one of the most important sectors of the Namibian economy because about 70 % of Namibia's population depend directly or indirectly on agriculture (Mushendami *et al*., 2006).

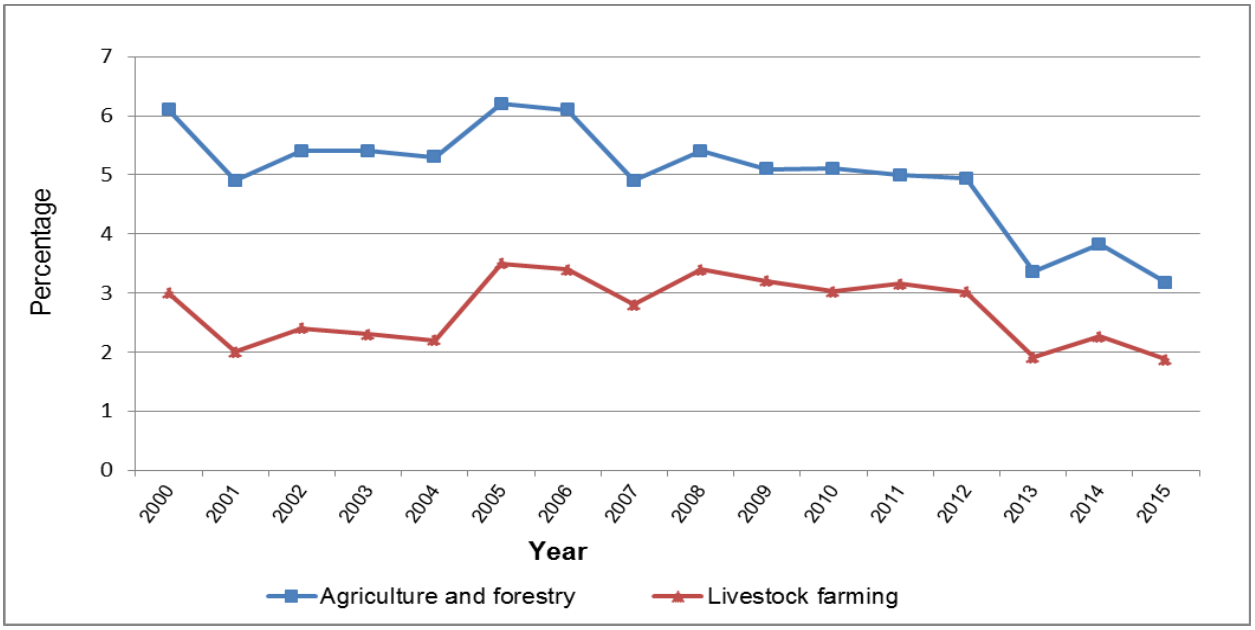

Figure 3.1: Contribution of agriculture to GDP for the years 2000–2015
Source: Meat Board of Namibia, 2015.

The Namibian livestock and meat sector plays a critical role in economic growth and in job creation in the agriculture sector. The livestock sector accounted for 75 % of gross agricultural production in 2009 (Namibia Agricultural Policy, 2015). Namibia has a comparative advantage in the production of livestock. This has resulted in the country's ability to compete on international lucrative meat markets such as the European Union, European Free Trade Area (Norway) and the United States of America.

About half of the live animals produced in Namibia are exported live to South Africa each year. Local abattoirs typically supply the domestic market. Amongst the meat products, beef production is the major livestock farming activity in Namibia, followed by mutton/lamb, goats and pork. With regard to chicken, Namibia had been relying on imports for own consumption, but recently a number of poultry productions have been established. Figure 3.2 below presents the Namibian livestock population by type from 2009 to 2015. Pig and poultry had the lowest populations between 2009 and 2011, although the poultry population shot up in 2013, exceeding those of cattle and sheep in that year. The rapid increase in the poultry population could be attributed to the opening of a chicken meat production plant by Namib Poultry (Pty) Ltd, which is the only exotic broiler production company in the country, as well as to an increase in numbers of small-scale exotic chicken (layers) producers around the country. The cattle population, on the other hand, has been stable, although fluctuating between 2.4 million in 2009 and 2.9 million in 2015.

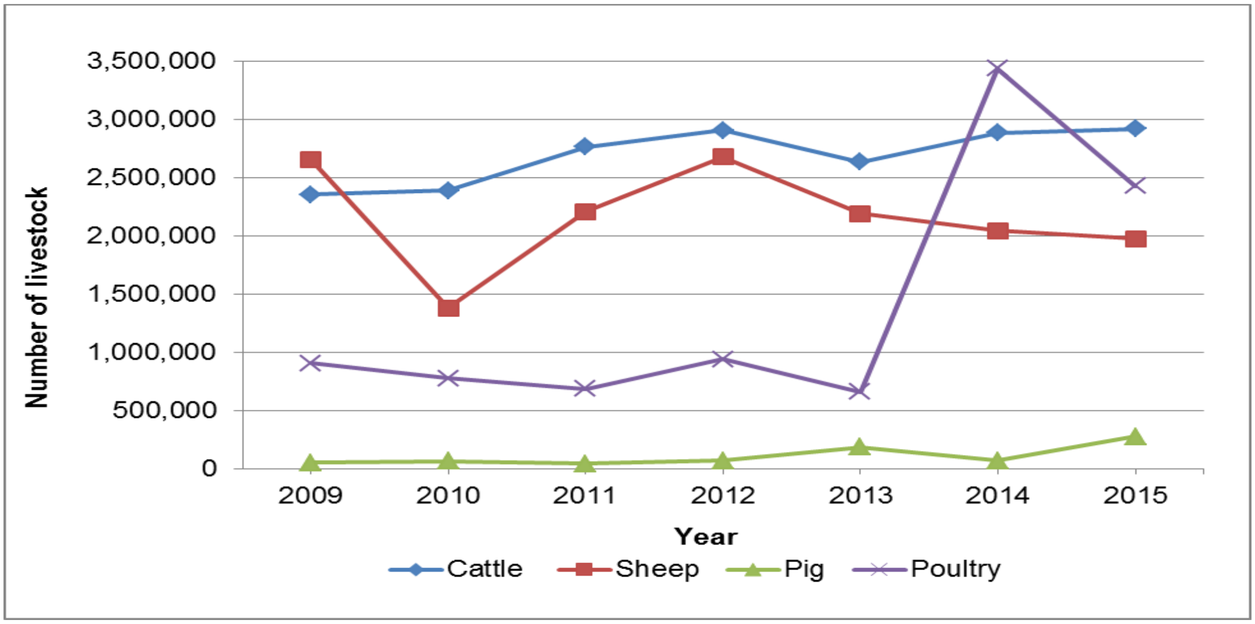

Figure 3.2: Namibian livestock population (2009–2015)
Source: Ministry of Agriculture, Water and Forestry (2015).

According to Strydom & Müseler (1998), Namibia's meat industry is heavily export oriented. About 85 % of annual total cattle and small stock production is exported, as either meat or live animals. Strydom & Müseler (1998) further reported that only 15 % of red meat production is made available for domestic consumption.

With regard to world meat consumption, the Food and Agriculture Organization (FAO) (2015) has predicted that the world will be faced with challenges that might hinder the goals of satisfying increasing and changing demands for animal products, while at the same time sustaining the natural resource base, such as soil, water, air and biodiversity. Like global agriculture, Namibia is also expected to face increasing challenges driven by trends in the livestock sector, such as a shift in consumer preferences from white meat (pork and chicken) to ruminants, attributable to tastes, health and/or religious reasons. Further to that, Namibia, being a drought-prone country and also subject to the effects of climate change, would probably opt to avoid pressure and competition for common property resources such as grazing and water. Notwithstanding this, the FAO (2015) reported that demands for food variety have been growing due to increases in global incomes. The FAO (2015) further indicated that the world was then experiencing an increase in demand for health safety and quality foods products such as meat, eggs and milk, compared with foods of plant origin such as cereals. The world has also realised a growing complexity in global meat markets, motivated by consumer-related demands for certain product types, quality and safety, which increasingly affect not only the patterns of trade, but demand for those products, (FAO, 2015).

3.2 RESEARCH AREA

This study was conducted in Namibia, which is situated in the south-west of the African continent. The country's population is estimated at 2.3 million, based on the 2011 population census and estimated grow of 1.4 % per annum (Namibian Statistics Agency, 2014). According to the Namibian Statistics Agency (2014), the majority of the population is engaged in agricultural activities, such as livestock and crop farming, dairy production, and poultry production for both commercial purposes and subsistence farming. The Agricultural Statistic Bulletin (2011) reported that agriculture in Namibia plays a major role in the economy as a vital source of livelihood for most families in terms source provision of food, income generation, and job creation, and contributes highly to national foreign exchanges. The agricultural sector of Namibia covers crop farming and livestock rearing. The northern part of the country is typically categorised as communal land, although there are pocket areas in other regions, such as Omaheke and Karass Regions, were communal land tenure exists.

According to Nathinge (2011), Namibia, with a density rate of three persons per km^2, is ranked amongst the most sparsely populated countries in the world. Over seventy per cent of the Namibian surface area is classified as highly susceptible to erosion. Vegetation in Namibia is made up of desert, savanna, and woodlands. The woodland and savanna forest that make up the fertile highly area receives average rainfalls of above 500 mm per annum and is found in the northern part of the country where subsistence crop and livestock farming takes place. The central area of the country, with an average rainfall pattern ranging between 200 and 400 mm per annum, is a predominantly cattle farming area, while the southern area, with a rainfall pattern ranging between 50 and 300 mm per annum, is predominantly suitable for small stock (sheep and goat) farming.

As with crop farming, animal husbandry is divided into subsistence and commercial farming sectors. The subsistence set-up is mostly practised in the northern part of the country where farmers practise mixed farming of different crop types and animal husbandry. The commercial livestock farming sector contributes the highest quantity of meat consumed in the country, more than does the collective farming sector, where livestock is mostly reared for status and wealth.

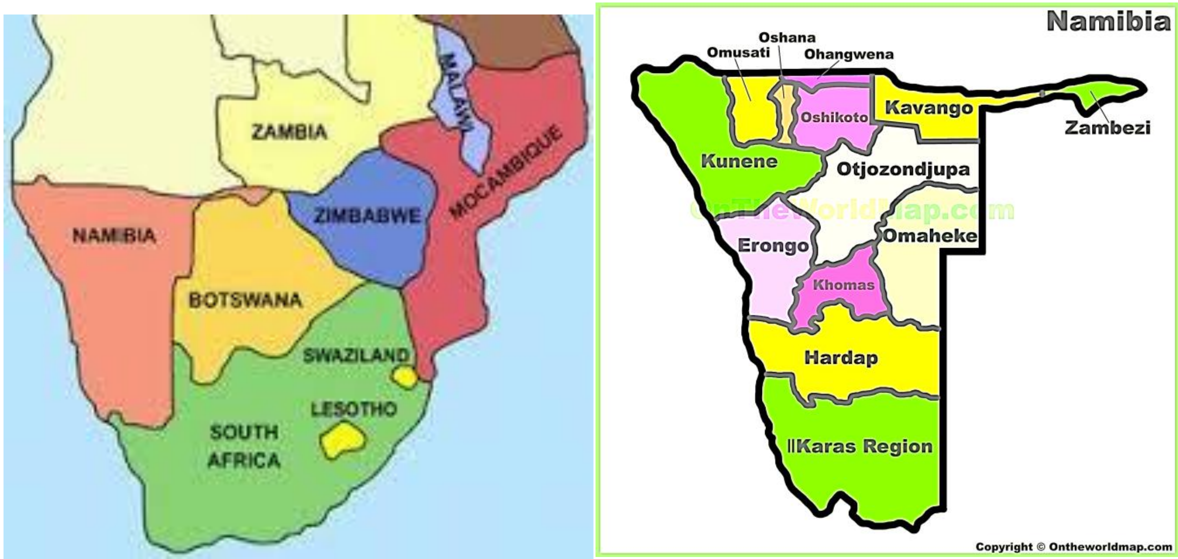

Figure 3.3: Map of the Sothern African countries (left) and Map of Namibia administration regions (right)
Source: On the worldmap.com.

3.3 BEEF

Beef production is one of the important rural farming practices in Namibia. The commercial sector normally produces beef destined for the European Union, European Free Trade Area, and the USA, and is valued because of the area's disease-free status. Beef cattle produced in communal areas north of the Veterinary Cordon Fence are typically sold on the open market, as well as to local abattoirs for domestic consumption or export to South Africa.

The meat industry of Namibia is highly regulated through policy instruments that in most cases are designed to accelerate value addition. Marketing institutions, such as the Meat Board of Namibia, were established to facilitate the purchasing, slaughtering and processing of Namibian meat and meat products. According to the Meat Board of Namibia (2016), Namibia produces approximately 55 000 tonnes of beef per annum, and eighty per cent of that is exported to South Africa and Europe. The Meat Board of Namibia (2016) reported that 150 000 weaners are shipped to South Africa every year. Furthermore, the Meat Board of Namibia (2013) has reported that local beef consumption in Namibia was stable between 2007 and 2012, and ranged between 26 000–28 000 metric tonnes per annum.

The commercial farming sector, and in particular the livestock farming sector, is considered to be the largest employer in the country. Namibia has been enjoying a comparative advantage in exporting cattle and beef to South Africa, the European Union and the European Free Trade Area. The country is also one of the few African countries that have meat processing facilities that meet the strict import regulations for the European market.

Figure 3.4 below shows figures for the production, import, export and consumption of Namibian beef. From 2000 to 2011, beef production in Namibian was stable, ranging between 46 000 metric tonnes in 2009 and 49 000 tonnes in 2011. However, in 2012 the country experienced a devastating drought that affected production, and eventually reduced beef export and consumption in that year.

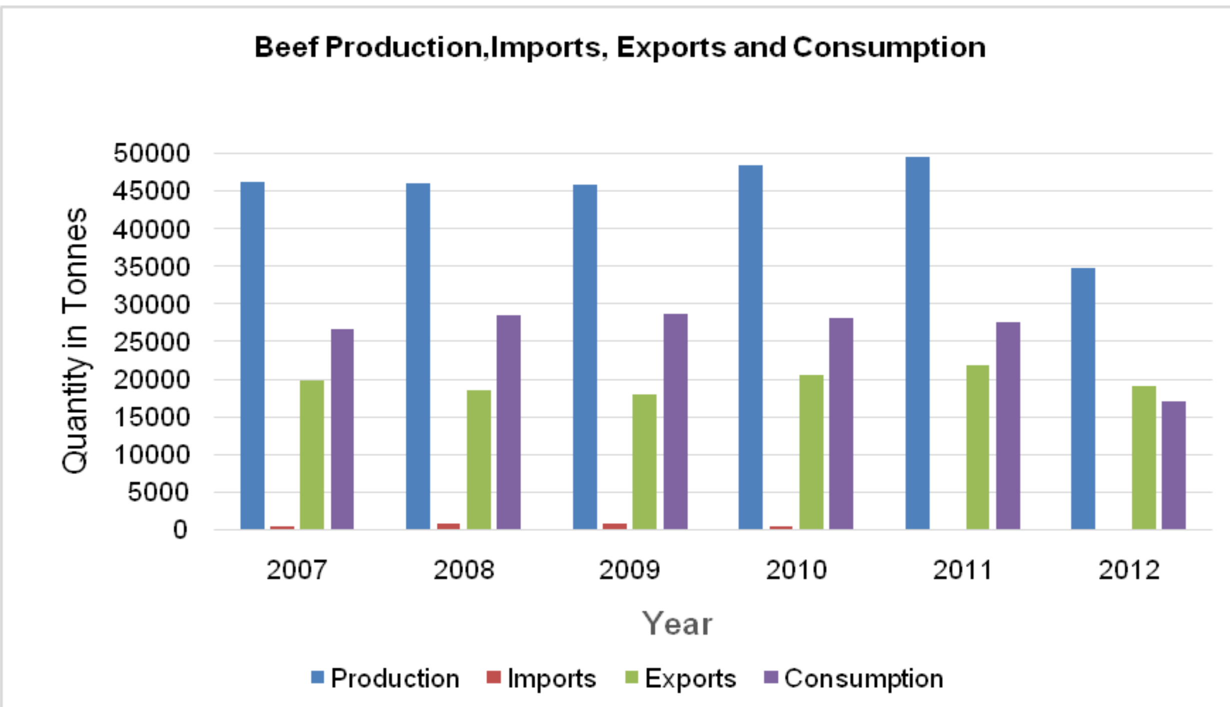

Figure 3.4: Beef production, import, export and consumption for the period 2007–2012
Source: Ministry of Agriculture, Water and Forestry (2015).

Mushendami, Biwa & Gaomab II (2006) reported that the Namibian beef sector accounts for seven per cent of national merchandise exports. They further emphasised that the beef industry was not only essential for economic growth and job creation, but more so for livelihoods and food security, especially for the rural community of the country where over forty per cent of households own or have access to cattle.

3.4 MUTTON

Sheep constitute one of the livestock subsectors that are of economic relevance to Namibia. During the 1950s, sheep farming was comprised of seventy per cent Karakul sheep, out of an estimated 4.5 million small stock population south of the Veterinary Cordon Fence (VCF). However, the recent decade statistics show an increase in mutton sheep farming, and a decrease in Karakul sheep farming. The Namibian Agricultural Policy (2015) estimates that in 2004 more than ninety per cent of all small stock produced in Namibia were mutton sheep. The mutton breeds, cross-breeds and hybrids that are currently produced in Namibia are Dorper, Damara, Van Rooy and Blackhead Persian.

Namibian sheep and other small stock such as goats are sold live at auctions, either directly to local buyers, abattoirs and butchers, or on an ad hoc informal basis. However, local buyers or agents buy sheep for upkeep for a given period until they are ready to be exported live to South Africa. The Namibian Government, with the ambition to stimulate value addition while reducing export of raw materials in the small stock sector, introduced what it called the “Small Stock Marketing Incentive Scheme (SSMIS)”. The SSMIS is a policy tool aimed at supporting local value addition through established small stock abattoirs by controlling the ratio of live sheep exported, vis-à-vis those delivered to local slaughterhouses.

By enforcing value addition through local slaughtering and processing of meat cuts, the government has been discouraging the export of live sheep. Before the introduction of the Small Stock Marketing Incentive Scheme by the government, the number of sheep carcases exported live out of the country rose from an average of 85 000 tonnes per year during the 1990s to 390 941 tonnes in 2004. After the introduction of the Small Stock Marketing Incentive Scheme in 2004, live sheep exports stood at 53 %, while average sheep carcass exports were 43 %, leaving domestic consumption of sheep with only four per cent in the year under review (Meat Board of Namibia (2015). Figure 3.5 below presents the proportions of live sheep exported to South Africa and those delivered to Namibian slaughter houses, as well as sheep carcasses exported to South Africa and the European Union. The average auction price per live sheep in 2004 was N$304, while the formal market sheep production of 922 860 head was worth N$285 million (Meat Board of Namibia, 2015). Mutton carcases and cuts exported gained the upper hand, when compared to goat exports. About 262 972 goats were exported in 2004 to KwaZulu-Natal and the Eastern Cape, South Africa, mainly for Muslim, Zulu and Xhosa people who buy live goats for rituals and ceremonial purposes.

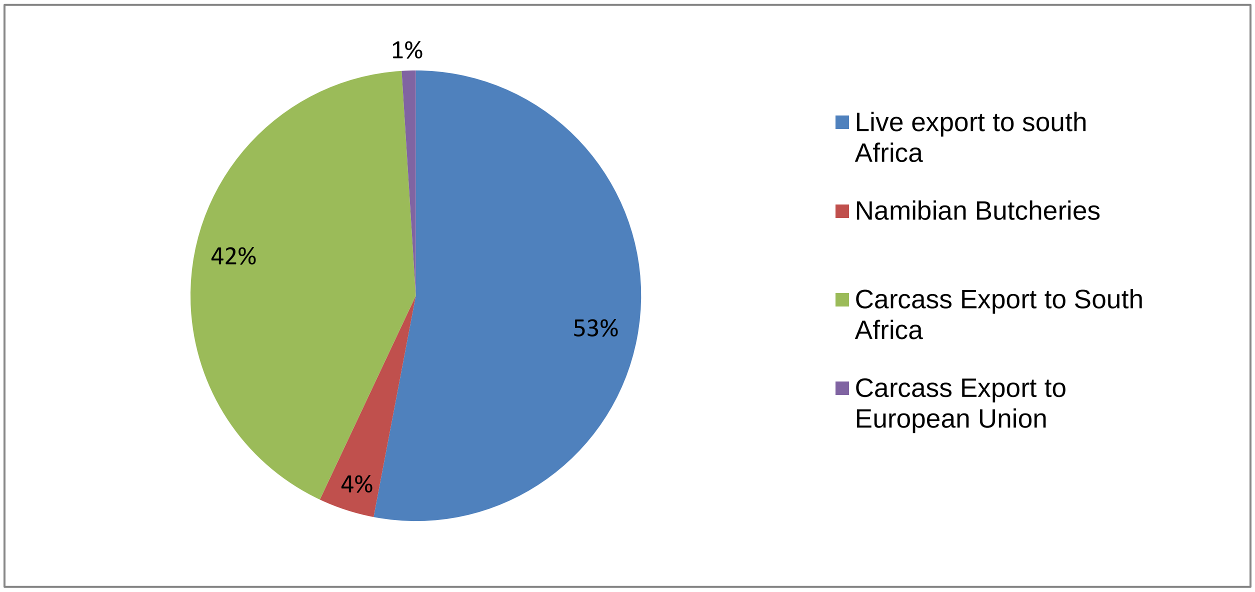

Figure 3.5: Live and sheep carcases exported and delivered to local abattoirs in 2004
Source: Meat Board of Namibia (2015).

3.5 PORK

Pig farming, especially for commercial purposes, is a relatively new industry in Namibia. Namibia has been a net importer of pork and pork products. However, in recent years many farmers have shown interest in farming with pigs, and pig farming is taking its rightful share in the market. All Africa (2012) reported that after the introduction of a Pig Protection Scheme in October 2012, local production had increased to the extent of supplying approximately seventy per cent of the Namibian market, while the remaining thirty per cent is imported, mainly from South Africa.

The Pig Protection Scheme was introduced on a trial basis by the Government of the Republic of Namibia to promote and protect local pig producers from competing with imports that had been dominating the domestic market. The Pig Protection Scheme obliged retailers and traders to first purchase pork from local producers as a condition for receiving an import permit. According to the Meat Board of Namibia (2015), there are about 600 pig producers in Namibia, and the majority of those are farming on a very small scale of less than ten pigs. At present, all pork produced in Namibia is consumed locally. Figure 3.6 below presents the number of pigs produced and marketed between 2010 and 2015.

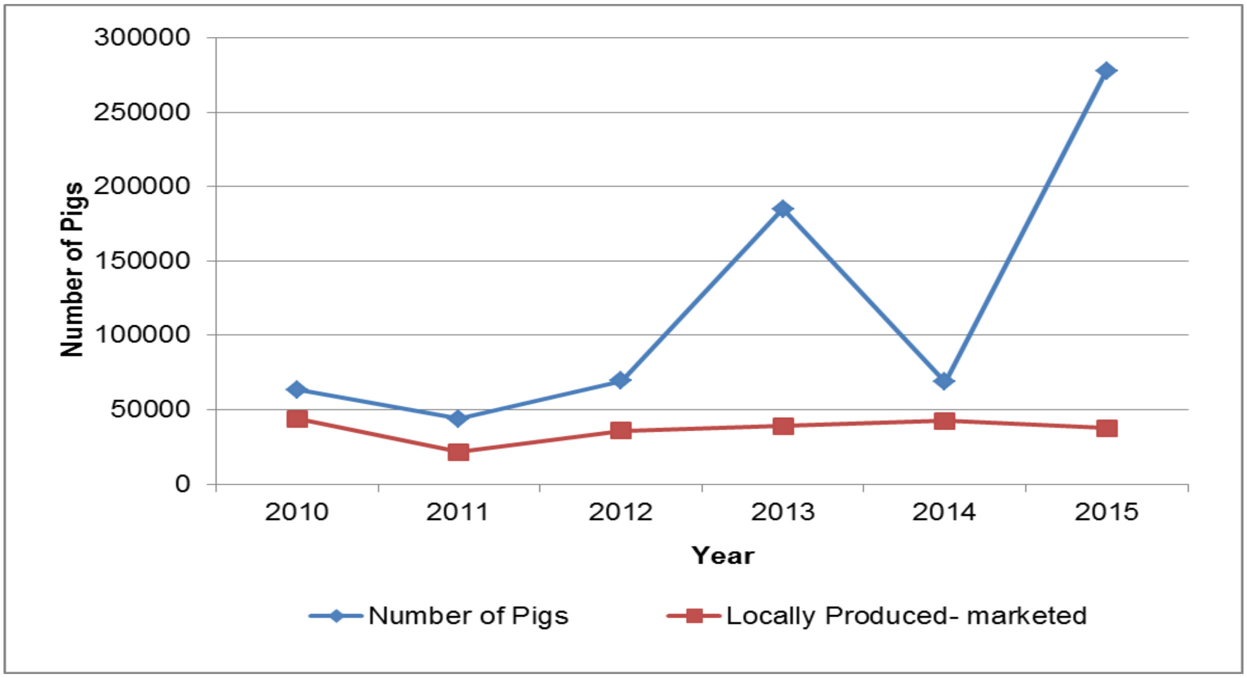

Figure 3.5: Pig population and marketed between 2010 and 2015
Source: Ministry of Agriculture, Water and Forestry (2016).

3.6 CHICKEN

Prior to the inception of the Namibia Poultry Industry in 2012, Namibia had been relying on imports of poultry products for its domestic consumption. In 2010, meat imports totalled 40 000 tonnes and about 77 % of those imports were chicken (Namibian Statistics Agency, 2014). The main importers of chicken into Namibia are South Africa, Argentina, the United States of America, Denmark, and Brazil. Although imports dominate domestic chicken consumption, the country, and especially the communal area, produces different types of poultry such as indigenous chicken, exotic chicken (broilers and layers), ducks, pigeons and geese (Namibian Census of Agriculture, 2015). Apart from broilers, other poultry and poultry products are produced for household consumption, income generation and sale at free markets. The poultry population in Namibia is presented in Figure 3.7 below. According to the Namibian Census of Agriculture (2015), there has been a significant increase in poultry population in Namibia. This increase in the chicken population could be because the many small-scale egg producers are currently importing one-day-old chicks from South Africa. According to the Namibia Census of Agriculture (2013/2014), about 41 % of chickens produced in Namibia were lost due to diseases.

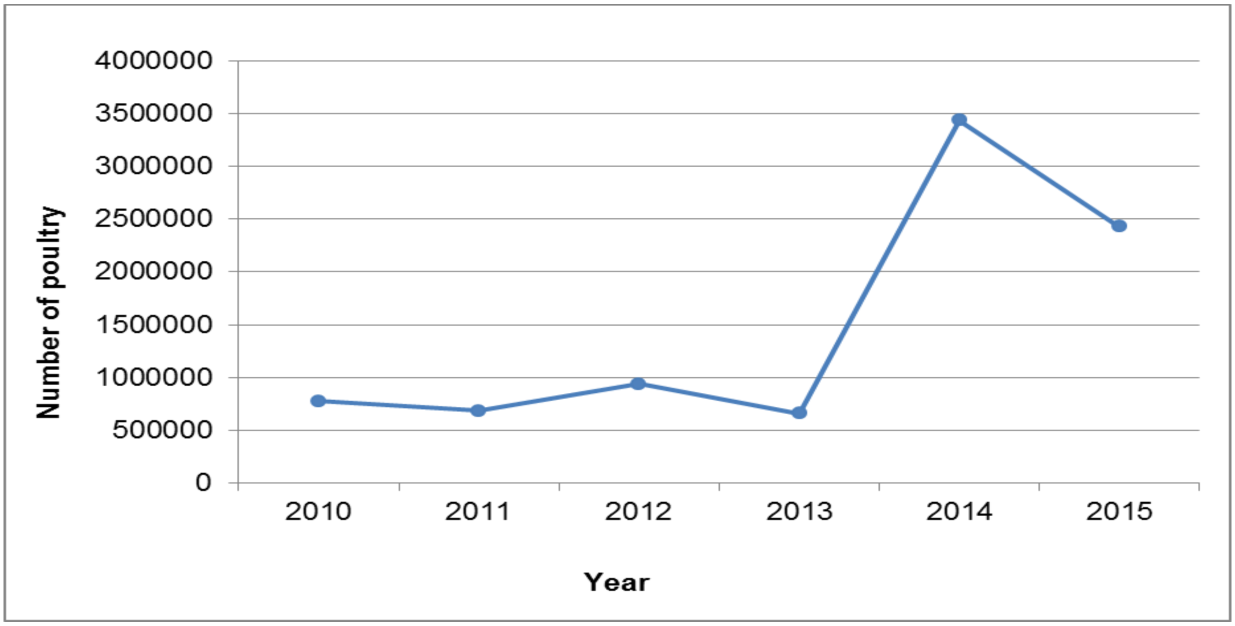

Figure 3.6: Poultry population between 2010 and 2015
Source: Ministry of Agriculture, Water and Forestry (2015).

3.7 CONCLUSIONS

The chapter has given an overview of the Meat Industry of Namibia. The Namibian agricultural sector is conducted utilising two types of land ownership, namely the commercial sector producing meat for the export market, and the collective or subsistence farming sector producing mainly for household consumption, wealth and/or status. The country has a comparative advantage in the production of livestock, and the livestock industry accounted for 75 % of gross agricultural output in 2009 (Namibia Agricultural Policy, 2015). Beef production, especially for commercial purposes, is one of the important agricultural farming practices in Namibia, followed by small stock (mutton/lamb and goat), poultry, and pork farming, respectively. On average, more than 50 % of cattle and small stock produced in Namibia is usually exported live to South Africa every year. All the pork and poultry quantities produced are consumed locally. Furthermore, Namibian extensively imports chicken and pork products to cover the deficit in those products.

CHAPTER 4

RESEARCH DESIGN (METHODOLOGY)

4.1 INTRODUCTION

This Chapter will give a presentation of the general research methodology of the study and present the model design and procedures for hypothesis testing. Furthermore, the structural specification of the LA/AIDS and Rotterdam models will be presented. Lastly, data specification will be presented.

4.2 MODEL ESTIMATION

Recent studies, specifically in the area of agricultural econometrics, have been centred on complete systems of demand equations estimation (Taljaard, 2003). The advantage of this modelling is that it allows the researchers to estimate the per capita consumption, it reduces the degrees of freedom problems, and can also test restrictions on the parameters being estimated, instead of imposing them ad hoc. The models that are estimated in this study consist of four meat demand equations, namely for beef, mutton, pork and chicken. These models will be estimated using the restricted seemingly unrelated regression (RSUR) procedures. During the regression process, adding-up, symmetry and homogeneity restrictions will be imposed on the parameters of the models to ensure that the models are consistent with the econometric *a priori* expectations. The models to be estimated and compared are the Rotterdam and the LA/AIDS models.

4.2.1 The demand function and its properties

Both the Rotterdam model and the AIDS model are derived from maximising the following utility function:

$$U = v(q) \tag{4.1}$$

where q is a vector of the n^{th} good demanded, subject to the budget linear constraints:

$$\sum_{k} p_i q_i = x \qquad k = 1 \ldots n, \tag{4.2}$$

where x is the total expenditure, p_i is the price of the product and q_i is the quantity of the product consumed. Consumers have a broad range of products to purchase within the available income at their disposal. Therefore, as the first stage of budgeting, total expenditure is an allocation to different groups of products, such as durables, nondurables and service goods. According to Deaton & Muellbauer (1980), a consumer's preference for products within a group is based on a sufficient and essential condition for the second stage of two-stage budgeting, called "weak separability". The expenditure allocated to an individual product within a group is expressed as a function of prices and weighted total expenditure of products within that group. Since consumers base their decision to purchase the quantities (q_i) of certain products within a group g_i based on their purchasing power (total expenditure) and prices p_i of all goods in that group, this results in a Marshallian demand function defined by:

$$q_i = g_i(p, x) \quad i = 1, \ldots, 1 \tag{4.3}$$

Demand can alternatively be specified as a Hicksian compensated function of prices (p) and real income x^* and the resulting equation is:

$$q_i = G_i(p, x^*) \qquad i = 1, \ldots, 1 \tag{4.4}$$

G_i is a compensated demand $h_i(p,u)$. The change in prices of good 1 in Equations (4.3) and (4.4) will cause dp_1 change in q_i as follows:

$$dp_i = \frac{\partial g_i}{\partial p_i} dp_i \tag{4.5}$$

The appearance of dp_i on both sides of Equation (4.5) will keep real income constant and restrict the effect of change in price to substitute effect. The Slutsky matrix is given by:

$$S_{ij} = \left(\frac{\partial G_i}{\partial p_i} \right) \tag{4.6}$$

By taking the total logarithm differential of the real income demands:

$$d\ln q_i = \frac{\partial \ln q_i}{\partial \ln x} d\ln x^* + \sum_j \frac{\partial \ln q_i}{\partial \ln p_j} d\ln p_j \tag{4.7}$$

Whereas:

$$\partial \ln q_i = e^*{}_{ij} \tag{4.8}$$

When both sides of Equation (4.6) are multiplied by Equation (4.8), the resulting equation is:

$$w_i d(\ln q_i) = \left(\frac{p_i q_i}{c} \frac{\partial q_i}{\partial x} \frac{x}{q_i} \right) d\ln x^* + \sum_j \left(\frac{p_i q_i}{x} \frac{\partial q_i}{\partial p_i} \frac{p_j}{q_i} \right) d\ln p_j \tag{4.9}$$

and

$$w_i d(\ln q_i) = \left(p_i \frac{\partial q_i}{\partial x} \right) d\ln x^* + \sum_j \left(\frac{p_i p_j}{x} \frac{\partial q_i}{\partial p_j} \right) d\ln p_j \tag{4.10}$$

4.2.2 Separability

Separability is a notion normally assumed to estimate a demand system conditionally. It is assumed that commodities from the same group interact closely in the yielding of a utility function, and these commodities can be grouped together. Similarly, commodities that belong to a different utility function have weak substitution effect. This notion of separability can then be used to assume a number of responses which can be estimated. According to Svensson (2013), there are four types of separabilities, which are discussed as follows:

The first one is a weak separability in which a marginal rate of substitution for commodities in the same group is not affected by the consumption of a commodity in another group. Weak separability implies that the ratio of marginal utility of two goods belonging in the same group cannot be influenced by the quantity consumed of products in different groups. For that assumption, the utility function is denoted as:

$$u(q) = f[u_1(q_1)] + u_2(q_1), \ldots, uN(qN)] \tag{4.11}$$

where q_R is a vector of the quantity of goods in the Rth group.

The second assumption is a strong separability (additive separability), which implies that a marginal utility of individual goods is independent of the quantity demanded of other products. The utility for strong separability is denoted by:

$$u(q) = f[u_1(q_1)] + u_2(q_1) + ... + uN(qN)] \quad (4.12)$$

The strong separability assumption specifies an incomplete system of demand equations, dependent on the prices of relevant goods, related goods and expenditure but excludes the upper stage budgeting process which may have less influence in decision making (Svensson, 2013). Svensson (2013) further argued that separability requires a priori knowledge on how commodities are grouped.

The third assumption is that of neutral-wants associations or Pearce-separasbility. This assumption implies the independence of the ratio of marginal utilities as a result of quantity consumed of a third good, whether inside or outside the group.

4.2.3 The Rotterdam model's theoretical specifications

As stated in the preceding chapter, the Rotterdam model was developed by Theil (1965). According to Mountain (1988), the Rotterdam model was the first model to be used specifically for consumer demand theory. Mountain (1988) further stated that the model was perceived to offer many advantages, compared with its predecessors, such as the linear expenditure system by Stone (1954). While most of the flexible model systems are derived from the utility function, the Rotterdam model took a different approach. The Rotterdam model is derived by differentiating a log-linear demand system, (Slottji, 2009; Clements & Gao, 2014). According to Clements & Gao (2014), deriving the Rotterdam model required first starting with specifying a general system of a differential demand equation for the indirect utility function, and then constraining the resulting equations to satisfy homogeneity and symmetry restrictions, where after the marginal share and Slutsky coefficients constant are used to parameterise the model.

The Rotterdam model can be estimated using either the relative price version or the absolute price version (Slottji, 2009). The real data of the Rotterdam model are estimated with finite differences of logs, as proposed by Stone (1954). From Equation (4.10) above, the defining of:

$\beta_i = p_i \dfrac{\partial q_i}{\partial x}$ and $\gamma_{ij} = \dfrac{p_i pj}{x} \dfrac{\partial q_i}{\partial p_j}$ produces the absolute version of the Rotterdam model as:

$$w_i d(\ln q_i) = \beta_i d \ln p_j x^* + \sum_j \gamma_{ij} d \ln p_j \qquad (4.13)$$

where: $\beta_i = p_i \frac{\partial q_i}{\partial x} = \frac{\partial p_i q_i}{\partial x}$ is a marginal budget share of the i^{th} good and this implies that an increase of a dollar in income will increase the budget spends on i^{th} good ($\sum_j \beta_i = 1$).

$\gamma_{ij} = \frac{p_i p_i}{x} \frac{\partial q_i}{\partial p_j}$ is the price coefficient used in a Linear Expenditure System, which forms a symmetric, negative semidefinite matrix with ranks equals the number of commodities -1, such that:

$$K = (\gamma_{ij}) = \frac{1}{2} PSP \qquad (4.14)$$

where *S* is the Slutsky matrix, *P* is a matrix with a price vector, and K is a Kronecker delta used by Deaton & Muellbauer (1980).

However, when changes in expenditure share ($w_i = \frac{p_i q_i}{x}$), is considered for the i^{th} good, the differentiated equation is written as follows:

$$dw_i = \frac{q_i}{x} dp_i + \frac{p_i}{x_i} dq_i - \frac{p_i q_j}{x^2} dx$$

$$= \frac{p_i q_i}{x} \frac{dp_i}{p_i} + \frac{p_i q_i}{x} \frac{dq_i}{q_i} - \frac{p_i q_i}{x} \frac{dx}{x}$$

$$= w_1 d \ln p_j + w_i d \ln q_i - w_i d \ln x \qquad (4.15)$$

For real data, the Rotterdam model is approximated with finite differences of logs, such that Equation 4.7 will yield:

$$\log q_i = \alpha_i + e_i \log x \sum_j e_{ij} d \log p_i \qquad (4.16)$$

where q_i is the quantity demanded for good i; m is the total expenditure of the group of goods being estimated; p_j is the nominal price for *j^th^* good; e_i is the total expenditure elasticity; and e_{ij} are the cross-price elasticities of the *j^th^* price on demand for good i, (Stone, 1954).

According to Taljaard (2003), the Slutsky symmetric equation for compensated cross-price elasticities e_{ij}, as proposed by Stone (1954), is written as $e_{ij} = e^*{}_{ij} - e_i w_j$ so that Equation (4.13) yields the equation which is a differential of the LES:

$$d \log q_i = \alpha_i \left(d \log x - \sum w_k d \log p_k \right) + \sum_j e_{ij}{}^* d \log p_{j\,i} \qquad (4.17)$$

The Rotterdam model postulates that the dependent variable is not a weighted share of the expenditure, and as a result, it not possible to impose symmetry restrictions on Equation (4.14) because it requires a budget share w_i. For example, when the restrictions are set on price elasticities such that e_{ij} = 0, this implies that there is no substitution effect, nor will there be an income substitution effect. To be in line with the demand theory, the cross-price elasticities e_{ij} is expected to be zero for unrelated goods, while the income effect is projected to be greater than zero. Fuji *et al.,* (1987) stated that the log-linear demand system from which the Rotterdam model is derived is not amenable to adding-up. Since Equation (4.14) is not expressed in a budget share (w_i) form, imposing symmetry restriction is not possible. Taljaard (2003), following Johnson, Hassan and Green (1984), supported the introduction of the budget share in Equation (4.14). The resulting weighted share equation is written as:

$$\bar{w}_1 d \log q_i = b_i d \log \bar{x} + \sum_j c_{ij} d \log p_j \qquad (4.18)$$

$\bar{w}$ is the average budget share weight for good i *(i =1,…n,)* between time periods and $t-1$;

q_i is the quantity demanded for good i at period t;

p_j is the nominal price of good *j* at time t;

denoting the total quantity (expenditure) demanded for *n* goods at time *t*;

b_i and c_{ij} are the parameters being estimated to verify the adding-up, the homogeneity and the symmetry conditions; t denote the indexes time, while d D denotes a cross-period first difference log-change operator, expressed as $dq_1 = \sum_j w^*{}_{jt} Dx_{jt}$

Whereas:

$$d\log \bar{x} = d\log x - \sum \bar{w}_k d\log p_k = \sum \bar{w}_k d\log q_k \quad (4.19)$$

$$b_i = \bar{w}_i e_i = p_i \frac{\partial q_i}{\partial x} \quad (4.20)$$

$$c_{ij} = \bar{w}_i e^*{}_i = \frac{p_i p_j S_{ij}}{x} \quad (4.21)$$

The equality in Equation 4.16 is an index, representing the proportional change in real expenditure;

$b_i = \bar{w}_i e_i$ is the marginal propensity to spend on the *i*th good, while

S_{ij} is the Slutsky substitution matrix for the (*i,j*)th term.

The Rotterdam model postulates that the weighted budget share change is the quantity consumed of good *i*, as a linear function of the change in real income, and the change in each of the *n* prices over *t* periods. According to Clements & Gao (2014), Equation (4.15) is comprised of a system of *n* equations, which means that there is one equation for each of the meat products, i.e. beef, mutton, pork and poultry. Once the Rotterdam model is specified, constraints restrictions can then be imposed on the parameters of the model (4.15). These are:

Adding-up: $\sum_k b_k = 1; \sum_k ck_{kj} = 0$ (4.22)

Adding-up implies that the sum of expenditure is identically equalled to the total expenditure in the system.

Homogeneity: $\sum_k c_{jk} = 0$ (4.23)

Homogeneity implies that all prices and the sum of the total expenditure elasticities is identically zero.

Symmetry: $c_{ij} = c_{ji}$ (4.24)

The homogeneity and symmetry restriction are imposed simultaneously during regression, while testing is done equation-by-equation.

4.2.4 Estimating elasticities of the Rotterdam model

Estimating elasticity of demand has been at the forefront of economic forecasting. Price elasticity of demand is a value that measures the responsiveness of quantity demanded for a product once the price of that product has changed. As in neoclassical economics, forecasting in the system of the equation also requires accurate predictions.

Expenditure elasticities for the Rotterdam model are defined by:

$$e_i = \left(\frac{\beta_i}{w_i} \right) \quad (4.25)$$

The compensated and uncompensated elasticities for the Rotterdam model are respectively defined by:

$$e^c{}_{ij} = \left(\frac{\gamma_{ij} - \beta_i \bar{w}_j}{\bar{w}_i} \right) \quad (4.26)$$

$$e^u{}_{ij} = \left(\frac{\gamma_{ij} \beta_i \bar{w}_j}{\bar{w}_j} \right) \quad . \quad (4.27)$$

The coefficients obtained from Equations 4.22, 4.23 and 4.24 would need to be interpreted based on the significance of their outcome. For that to happen, Taljaard (2003) proposed to use the variance operator for the compensated, uncompensated and expenditure elasticities, respectively, as:

$$Var\left(e_{ij}^{\ *}\right)=\left(\frac{1}{\bar{w}^{2}}\right)Var\left(\hat{\gamma}_{ij}\right) \tag{4.28}$$

4.3 SPECIFICATION OF THE AIDS MODEL

In the literature, both statistics and economic models, such as the Rotterdam model, linear regressions, generalised linear models, translog models, Probit, Logit, Tobit, ARIMA, Vector Autoregression, and Cointegration, have been used in domestic demand analyses. Amongst the popular models used in agricultural research is the AIDS model. Many advantages make the AIDS model the most popular. When specifying the AIDS model, Deaton & Muellbauer (1980) derived the AIDS model by permitting aggregations over consumers that depict the outcome of decisions which rational consumers make when buying products. The model postulates total representatives of consumer demand to denote the overall market. Because the AIDS model is nonlinear, Deaton & Muellbauer (1980) proposed the use Stone's (1954) price index to solve the nonlinear issues and make the estimation easier.

4.3.1 The theoretical specification of the AIDS model

As stated in the previous chapter, the AIDS model of Deaton & Muellbauer (1980) is nonlinear in the parameter. Deaton & Muellbauer (1980) specified the nonlinear AIDS demand system by following the approach used by Theil (1965) in specifying the Rotterdam demand system. While Theil (1965) derived his model from a differentiated log-linear demand system, Deaton & Muellbauer (1980) on the other hand specified their model from a utility function of the general price-independent, general logarithmic (PIGLOG) cost function. This nonlinear AIDS model was found to exhibit certain technical problems when used in demand estimations. The PIGLOG model from which the nonlinear AIDS was developed is of the form:

$$\ln C(p,U)=(1-U)\ln(a(p))+u\ln(b(p)) \tag{4.29}$$

where p *lnx* is a vector of the unit price; $(U$ denotes the utility index that can be equal to zero $(U=0)$ or can be equal to one $(U=1)$; and $a(p)$ is a price index given by:

$$\ln a(p)=x_0+\sum_k \ln(p_k)+\frac{1}{2}\sum_k\sum_j \gamma_{kj}\ln p_k \ln p_j \tag{4.30}$$

and

$$\ln b(p) = \ln a(p) + \beta_0 \prod_k p_k^{B_2} k, j = 1,\dots,n \tag{4.31}$$

Holt and Goodwin (2009) proposed to apply Shephard's lemma to differentiate the logarithmic cost function with respect to a logarithmic price and formed a budget share equation for every product in the utility function. Holt and Goodwin (2009) further tested the share equation by removing the utility so that the total expenditure (y) for the utility maximising consumers will equal the cost function value. Finally, the indirect utility function $v(p, y)$ is substituted for U , in each share equation, and produces the corresponding Marshallian demand function of the form:

$$w_i = x_i + \sum_j e_{ij} \ln p_j + \beta_i (\ln(y) - \ln(p)) \tag{4.32}$$

where: $w_i = \frac{p_i q_i}{y}, i = 1,\dots,n$

The nonlinear AIDS model is defined by:

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln(p_{jt}) + \beta_i \ln\left(\frac{x}{p}\right) + \mu_{it} \tag{4.33}$$

where w_i is a budget share of good i ;

p_{jt} $\mathrm{p_j}$ is the price of good j at time t ;

x is a total expenditure on the four meat products;

μ_{it} is the random disturbance assumed to have a zero mean and a constant variance; and

P is a translog price index defined by:

$$\ln a(p) = \alpha_0 + \sum_k \ln(p_k) + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j w \tag{4.34}$$

Adding-up across the share equations and linear homogeneity of the demand function for the nonlinear AIDS model are defined by the following sets of equations:

$$\sum_i^n \alpha_i = 1, \sum_i^n \beta_i = 0, \sum_k^n \gamma_{kj} = 0 \text{ and } \sum_k^n \gamma_{jk} = 0 \text{ respectively.} \tag{4.35}$$

4.3.2 Linearising the AIDS (LA/AIDS) model

Flexibility in a demand system which has many desirable properties is one of the sought-after characters in econometric estimation. Moschini (1995) stated that, apart from the AIDS model's ability to possess many desirable properties, the LA/AIDS model can be approximated at the estimated stage. Moschini (1995) further stated that the AIDS model immediately satisfied the aggregation restriction, but was not easy to estimate because it is nonlinear in parameters. Alston, Foster & Green (1994), on the other hand, cautioned that using the price index from the equation defined in (4.22) complicates the estimation process, especially when time series are used.

Deaton & Muellbauer (1980) suggested that the AIDS model be linearised by using Stone's Price Index in the nonlinear function in Equation (4.22). The reason stated by Deaton & Muellbauer (1980) for using Stone's Price Index is to introduce the unit of measurement error. However, this unit of measurement was also found to be unsatisfying in estimating the LA/AIDS model because it is not responsive to change in the prices and quantity. Stone's share-weighted price index is defined by:

$$\ln P^* = \sum_{i=1}^{n} w_i \ln(p_t) \qquad (4.36)$$

Moschini (1995) suggested that the Stone's index in (4.24) is invariant and suggested the normalisation of all prices by their respective means to overcome the invariant problem. Likewise, Buse (1995) pointed out the problem of the errors in the variable that are caused by using Stone's index. To overcome that, Eales & Unnevehr (1988) suggested that a lagged share equation should be used. The resulting LA/AIDS model with the Stone's index is defined by:

$$w_{it} = \alpha_i + \sum_{j}^{n} \gamma_{ij} \ln(p_{jt}) + \beta_i \ln\left(\frac{x}{P^*}\right) + \mu_{it} \qquad (4.37)$$

The LA/AIDS model for Namibian meat products is estimated in the first difference. According to Sivaramane (undated), the AIDS model is one of the estimable consumer functional forms that allow the imposition of theoretical restrictions on a demand parameter by reducing the number of independent parameters to be estimated. From Equation (4.39), theoretical restrictions, such as adding-up, homogeneity and symmetry, were imposed and tested on the LA/AIDS equation. These restrictions are defined by:

Adding-up: $\sum_{i}^{n} \alpha_i = 1, \sum_{i=1}^{n} e_{ij} = \sum_{j=1}^{n} e_{ij} = 0$ (4.38)

Homogeneity: $\sum_{i}^{n} \beta_i = 0$ (4.39)

Symmetry: $e_{ij} = e_{ji}$ (4.40)

Apart from the use of the Stone's price index in linearising the AIDS model, other price index equations, as suggested by Asche and Wessels (1997), are the Tornqvist index, Paasche index and Laspeyre index equations. However, this study will concentrate its prediction by using the Stone's price index for the estimation.

4.3.3 Estimating elasticities using the LA/AIDS model

Estimating elasticities in using the LA/AIDS model is well documented. Green & Alston (1990), followed by Buse (1994), derived the expenditure elasticities e_i with respect to *ln* (x) from the derivative of Equation (4.39). The resulting expenditure elasticities for the LA/AIDS model are defined by:

$$e_i = 1 + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(x)}\right) = 1 + \left(\frac{\beta_i}{w_i}\right) \quad (4.41)$$

The uncompensated own and cross-price elasticities were obtained with respect to the derivative of $\ln(p_j)$ and are defined by:

$$e_{ij}^{LA/AIDS} = -\delta_{ij} + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(p_j)}\right)$$

$$= -\delta_{ij} + \left(\frac{\gamma_{ij}}{\bar{w}_i}\right) - \left(\frac{\beta_i}{\bar{w}_i}\right)\bar{w}_j \quad (4.42)$$

The Hicksian compensates price elasticities is derived and is defined by:

$$e_{ij}^{LA/AIDS} = -e_{ij} + e_i w_j$$

$$= -\delta_{ij} + \left(\frac{\gamma_{ij}}{\bar{w}_i} \right) + \bar{w}_j \qquad (4.43)$$

$$e_{ij}^{\frac{LA}{AIDS}} = -\delta_{ij} + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(p_j)}\right) = -\delta_{ij} + \left(\frac{\gamma_{ij}}{\bar{w}_i}\right) - \left(\frac{\beta_i}{\bar{w}_i}\right)\bar{w}_j$$

where for all the elasticities equations, δ_{ij} is the Kronecker delta, that is unity if $i = j$, and zero otherwise; $\bar{w}_j$ is the average budget share in each mat equation; and β_i and γ_{ij} are the parameters that are being estimated.

4.4 THE DATA

The data used in the study are for the monthly time series for the period from January 2001 to December 2013. The consumption and price data used in this study were obtained from the Namibian Statistics Agency, while the auction prices for meat products were obtained from the Meat Board of Namibia. The Namibia Statistics Agency (NSA) was established by the promulgation of an Act of Parliament, the Statistics Act No 9 of 2011, and became operational in September 2011 to provide economic, social and other demographic statistics, amongst others. The Meat Board of Namibia, on the other hand, is an agency of government established under the Meat Industry Act, Act 12 of 1981 to regulate, promote and facilitate Namibian livestock, meat and meat products in Namibia and elsewhere (Meat Board of Namibia, 2016).

The data were analysed using Eview7 to estimate the parameters for the compensated, uncompensated and expenditure elasticities of both the Rotterdam and LA/AIDS models.

4.4.1 Univariance properties of the data

According to Gai (undated), the first step toward building a model is to test for unit root in the series. The rationale for unit root testing, specifically for time series data, is to ascertain whether the series are stationary. When the data used in modelling is found to be non-stationary, the results obtained might be invalid because the model could predict unreliable and spurious results. For that reason, the data would require differencing before being used in the model.

One of the popular equations for testing the unit root in a series was developed by Dickey and Fuller in 1979, and is based on the hypothesis that the error terms are independent and normally distributed (Lombard, 2013). The Dickey–Fuller (DF) equation for testing unit root is:

$$y_t = \alpha + \beta t + p y_{t-1} + \varepsilon_t \qquad (4.44)$$

where: y_t is a linear function, time independent and identical, normally distributed with zero mean and variance one $(i.i.d, \varepsilon_t - N(0.\sigma^2))$. The DF was later criticised due to the assumption that the error term μ_t is uncorrelated. To test for the correlated error term, Dickey and Fuller developed what is known as the augmented Dickey–Fuller equation (ADF) by augmenting the original DF equation and adding a lagged value ΔY_t to Equation (4.44). The resulting equation is:

$$\Delta y_t = \alpha + \beta t + \phi y_{t-1} + \sum_{i=1}^{k} \phi \Delta y_{t-1} + \varepsilon_t \qquad (4.45)$$

where:

ε_t is a white-noise error term, and

$\Delta y_{t-1} = y_{t-1} - y_{t-2}), \Delta y_{t-2} = y_{t-2} - y_{t-3})$.

Δy_{t-1} is a lagged first difference that accommodates the serial correlations in the error term ε_t while y_t denotes the deterministic time trend at time t, t. Lombard (2013), following Ogundeji (2007) and Engle & Granger (1987), noted that the ADF test performs better than other tests do, and is regarded as the preferred test in many studies.

Data are non-stationary when the variance, mean and covariance change over time. The data used in the estimation of the Rotterdam and LA/AIDS models for Namibian meat data were tested for stationarity using the Augmented Dickey–Fuller test to determine whether data have unit root, or in other words, are non-stationary.

In this study, the ADF test was used and the results produced for the unit root tests are reported in Table 4.1 below. The ADF tests were carried out for all series in levels and first difference. The table consists of two parts. The first part shows the results of the test statistics on variables in levels, while the second part of the table shows the test statistics of the variables in first differences. Where necessary, the intercept and trend components were also included in both level and first differences. The hypotheses tested for each of the variables included in the models are as follows:

H_0: The series is stationary
H_1: The series is non-stationary

The series are said to be stationary when the calculated test statistics of a series are larger in absolute value than the critical value, and in that case, the H_0 is accepted. Once the critical value is lower than the test statistics in absolute value, the interpretation is that the data are non-stationary, and as a result, H_0 will be rejected in favour of the alternative hypothesis H_1 and it can be accepted that the series has unit root.

According to the ADF tests performed, it can be concluded that unit root would not be rejected in levels for all price variables. All meat weight and expenditure (RE) variables were found to be stationary in levels, as the value of the ADF statistics for those variables were higher than the critical value and all their probability (prob) values were significant at 5% level of significance. The ADF statistics values for all price variables, on the other hand, were all the lower than the critical value of the ADF statistics, and also insignificant at 5% level of significance. Nevertheless, the weight and expenditure variables were also transformed to the first difference for them to be in conformity with the price parameters before being employed in the estimating of the models. When series were differentiated, all variables including those that were non-stationary in levels, became stationary in first difference. Therefore, all series used in estimating the models were integrated of order 1, I(I).

Table 4.11: Results of the ADF test for unit roots in variables

	Variable in level				**Variables in 1st difference**			
Variables	**Lag length**	**ADF statistics**	**Critical value (95 %)**	**Prob.**	**Lag length**	**ADF statistics**	**Critical value (95 %)**	**Prob.**
BW	3	-7.98	-2.88	0.01*	10.00	-10.62	-2.88	0.00*
CW	0	-7.44	-2.88	0.00*	1.00	-9.56	-2.88	0.00*
PW	1	-5.36	-2.88	0.00*	3.00	-10.99	-2.88	0.00*
MW	0	-6.29	-2.88	0.00*	4.00	-9.13	-2.88	0.00*
BP	0	-1.19	-2.88	0.68	0.00	-13.10	-2.88	0.00*
CP	1	-2.13	-2.88	0.23	0.00	-18.52	-2.88	0.00*
PP	2	-1.47	-2.88	0.55	1.00	-12.97	-2.88	0.00*
MP	0	-1.14	-2.88	0.56	0.00	-15.82	-2.88	0.00*
RE	0	-10.73	-2.88	0.00	3.00	-10.61	-2.88	0.00*

*Means significant at 5 %

As emphasised by Barnett (1979), flexible functional forms can only be useful in prediction if they have satisfied the theoretical condition. Barnett (1979) further emphasised the point that when non-stationary time series data are used in modelling, the results produced might be unreliable and spurious, and would lead to poor forecasting and interpretation. From Table 4.1 above, the series that were found to be non-stationary in levels became stationary in first difference, and their ADF statistics were greater than the critical value, at 5 % level of significance. Based on that, the null hypothesis (H_0) was rejected and the alternate hypothesis (H_1) was accepted, implying that the data were stationary in first difference. On that basis, the series used in estimating the LA/AIDS model is integrated of order I(1).

4.5 TEST FOR STRUCTURAL CHANGE

A structural break is a sudden change in time series data caused by either political change, the introduction of a policy, or a natural disaster that caused a spike in prices of inputs, amongst other things. Testing for structural break, specifically in economic data, determines whether there was an abrupt change that could affect the relationship in the series being examined.

According to Jha and Sharma (2001), structural breaks result from the occurrence of an incident in the economy that significantly affects the variables being studied. Jha and Sharma (2001) further indicated that structural breaks could result in a permanent shift in the level or the slope (or both) of the series, although that shift might not change the basic nature of the series.

Structural break can be detected by examining the residuals from the fitted model. A structural break represents the period(s) where the residuals exceeded two standard deviations. To account for the change in the series, an intercept and slope dummy for that specific month are introduced into the equation. The residual plot for the beef equation presented in Figure 4.1 below indicates that the residual plot for beef exceeded two standard deviations during the first month of 2001, the second month of 2003, and the first month of 2013. The cause for the breaks in the series in 2001 and 2013 can be attributed to the droughts that killed much livestock in Namibia in the years 2000 and 2012, respectively. The break in 2003, on the other hand, coincided with the highest record of beef exports to the European Union through the African, Caribbean and Pacific (ACP) Agreement, where Namibia was granted duty-free, quota-free beef exports of 13 000 tonnes.

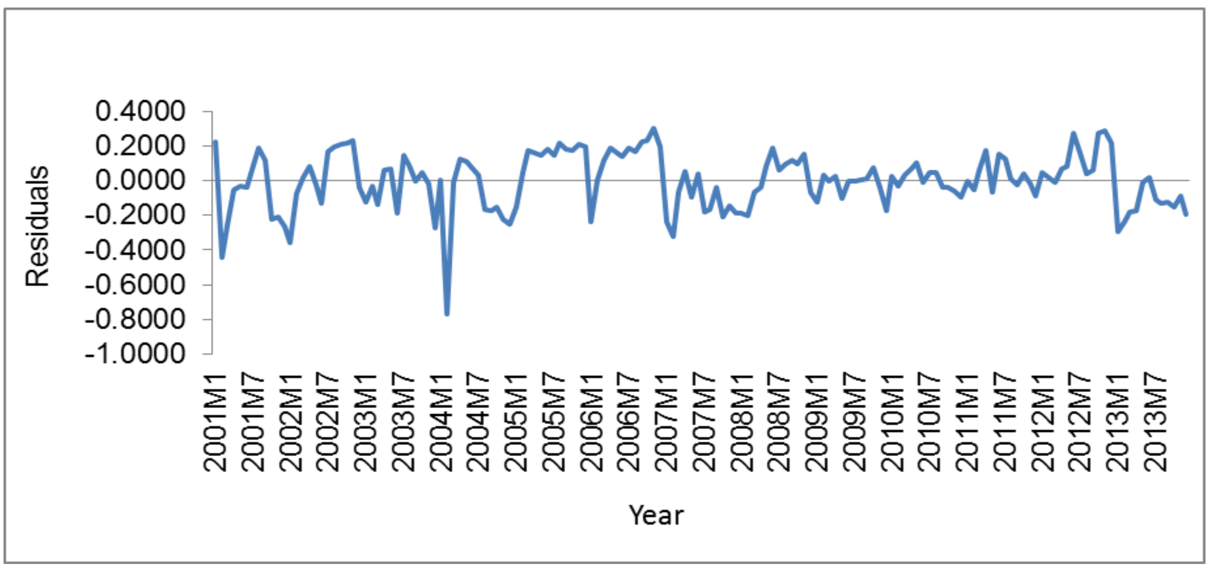

Figure 4.1: Residual plot for the beef share equation in two standards of error deviation

The residual plot for mutton (Figure 4.2 below) shows that the standard deviation surpassed the two standard error bands during the second month of 2007. The events coincided with the adjustment in the Small Stock Initiative Scheme ratio of 1:1 after its inception in July 2004. The ratio was adjusted to 2:1 from March 2005 to August 2006, but between September 2006 and February 2007, the ratio was increased to 6:1, which resulted in increased numbers of sheep being delivered to local abattoirs (Namibia Statistical Bulletin, 2011).

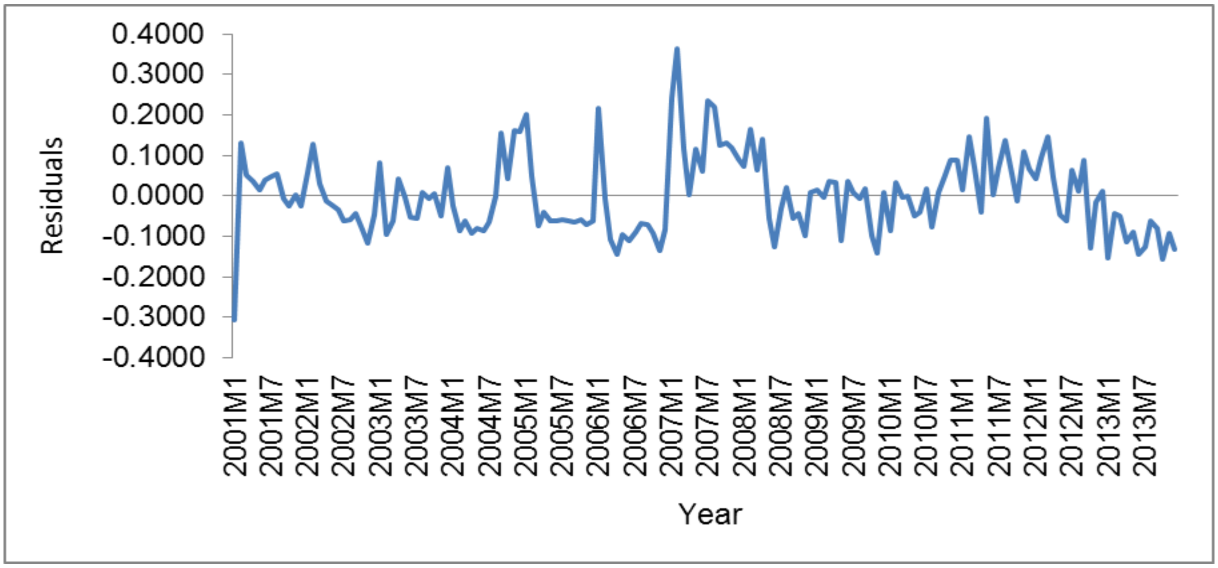

Figure 4.2: Residual plot for the mutton share equation in two standards of error deviation

Figure 4.3 below shows the residual plots for the chicken share equation. As with the beef share equation, the residuals for the chicken share equation passed the positive 2 standard error bands during the seventh month of 2001, the second month of 2004, and the first month of 2013.

Although a break in the chicken series indicates a possible occurrence of an event in the industry, it is not clear as what could have happened during that time. However, since Namibia was a net importer of chicken meat during this period, a possible explanation could be attributed to the further opening up of the domestic poultry market due to trade agreements, such as the ACP Agreement that Namibia became a signatory to in 2000.

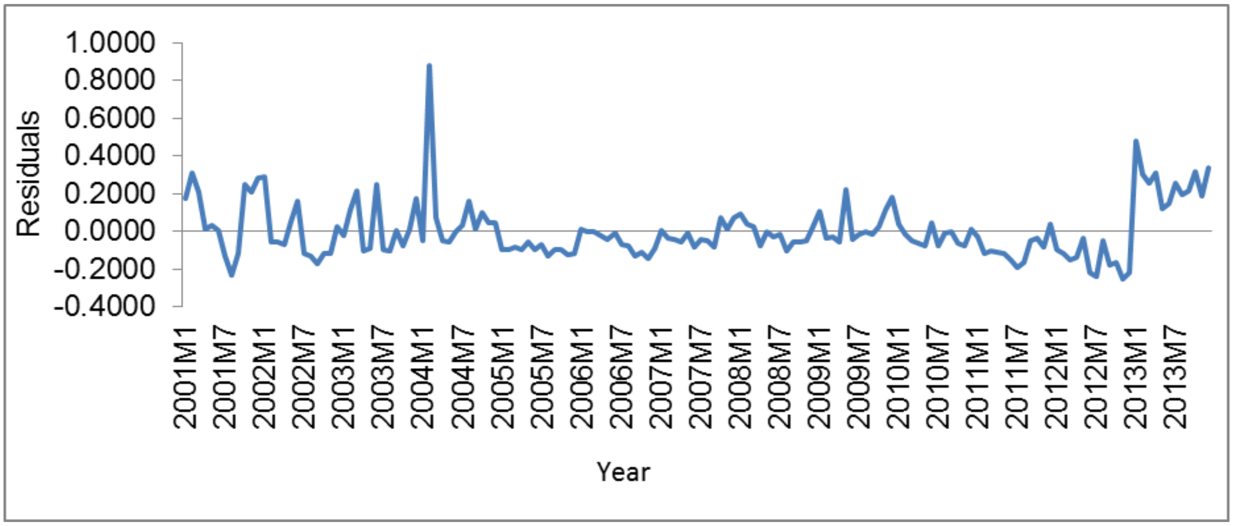

Figure 4.3: Residual plot for the chicken share equation in two standards of error deviation

The results for the residual plot for pork are presented in Figure 4.4. There is no structural break within any period of the pork share equation. The residual plot for the pork equation ranges between 1 and -1.

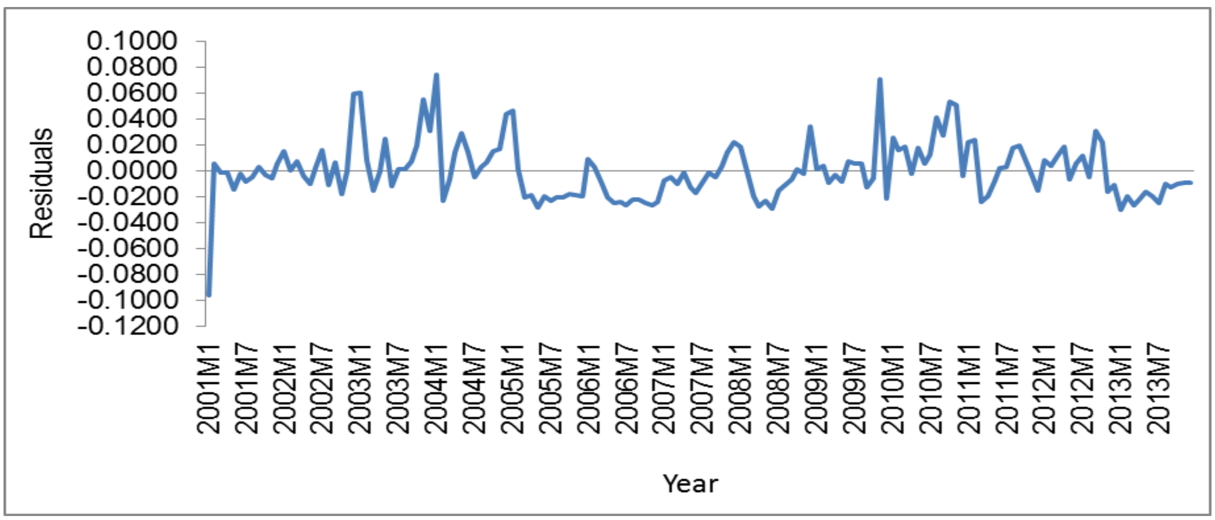

Figure 4.4: Residual plot for the pork share equation in two standards error deviation

During estimation, the slope dummy was introduced to each of the share equations to capture the effects of the structural change, as identified. However, all dummies introduces were insignificant when employed during estimation. As a result, the share equations for all meat products were estimated without dummies.

4.6 CONCLUSION

This chapter presented the general research methodology of the study, as well as the design and procedures for hypothesis testing. The theoretical specifications considered are those of the Rotterdam and LA/AIDS models. The models were tested for four products, namely beef, mutton, pork, and chicken. Before estimation of the model, the data were tested for unit root to ascertain whether the data were stationary. Further to the unit root test, structural break in the data was tested. Equations for the Rotterdam and LA/Aids models, homogeneity and symmetry, as well as their respective compensated, uncompensated and expenditure elasticities, were also specified. The data used in the study were monthly time series data for the period from January 2001 to December 2013. The consumption and price data used in this study were obtained from the Namibian Statistics Agency, while the auction prices for meat products were obtained from the Meat Board of Namibia. Beef and chicken weights, as well as beef, chicken and pork prices, were found to have a significant trend in levels. However, after differencing, the series became stationary in first difference. Based on the ADF tests, it was concluded that the series used in the estimation of the two models were integrated of order one I(1).

CHAPTER 5

RESULTS

"Conspicuous consumption of valuable goods is a means of reputability to the gentleman of leisure".

- Thorstein Vebren

5.1 INTRODUCTION

This chapter presents the outcome of the tests obtained from the estimation of both the Rotterdam model and the LA/AIDS demand system model for four meat products in Namibia. The parameters of each model are estimated and reported. The parameters that were estimated were later used to calculate the compensated and uncompensated prices, and the expenditure elasticities for the meat products. The chapter will proceed with the presentation of the results from the Rotterdam model, followed by the AIDS model.

Taljaard (2003) stated that the parameterisation of these two models has different assumptions. One of the assumptions mentioned by Taljaard (2003) is that the Slutsky term and the marginal expenditure share are constant in the Rotterdam model, while in the LA/AIDS model they are assumed to be the function of the budget share. That means, it is not possible to test the two models against each other directly before estimation. As a result, each model will be estimated individually to obtain its parameters, expenditure, and compensated and uncompensated elasticities.

The rest of this chapter is presented in two parts. The first part will give a description of the procedures followed to arrive at the results as obtained from the regression of the Rotterdam model on the Namibian meat data. In addition, the Wald test statistics that show the results of imposing homogeneity and symmetry restrictions before estimating the parameters of the model will also be presented. The second part of the chapter will show the procedures followed to obtain the parameters and elasticities for the LA/AIDS model. As was done during the estimation of the Rotterdam model, the results of homogeneity and asymmetry restrictions for the LA/AIDS model will also be presented, as well as the results of the compensated and uncompensated elasticities.

5.2 RESULTS OF THE EMPIRICAL APPLICATION OF THE ROTTERDAM MODEL ON THE NAMIBIAN MEAT DATA

As stated in the literature review, the Rotterdam demand model is one of the leading examples of the system of equations approach to modelling. In addition, the model's simplicity in application has contributed to its popularity and influential role in econometric estimation. As stated earlier, the parameters of the model were estimated using the RSURE method, while imposing restrictions. The obtained parameters were used to calculate the expenditure elasticities, compensated and uncompensated own-price, and cross-price elasticities. Barten (1993) demonstrated that the Rotterdam and AIDS models cannot be tested directly against each other. Following Barten (1993), Taljaard (2003) proposed that the two models should be estimated separately and the decision of which model best fits the data should be done using pair-wise and higher order tests. Based on that, the Rotterdam model was estimated separately before the results were compared with those of the LA/AIDS model.

5.2.1 Testing for restrictions in the Rotterdam model

The Rotterdam model described by Theil (1965) and Barten (1993) is derived from a theory of consumer behaviour which maximises a utility function. As stated in Chapter 4, the Rotterdam model is expressed as a weighted share equation with restrictions such as homogeneity, symmetry and adding-up being imposed. For the Namibian meat data, the homogeneity and symmetry restrictions were tested using the SUR method before the model was estimated by the RSURE process. The null hypothesis for homogeneity implies zero homogeneity in price parameters, while the alternate hypothesis indicates non-homogeneity in price parameters of Namibian meat products. The results of the Wald statistic values and their corresponding p-values are presented in Table 5.1 below.

All the Wald test statistics were insignificant, except for the homogeneity tests for the beef share equation. When the Wald test statistic for a share equation is significant, the restriction cannot be imposed for that equation. The p-values in Table 5.1 indicate the probability of rejecting the null hypothesis for an individual equation. The likelihood of rejecting a null hypothesis for the beef equation is 4%, implying that the price parameters in the beef share equation are non-homogeneous. The adding-up restriction is ensured automatically in a share of equation system when the conditions of homogeneity and symmetric restrictions are tested on price variables

Taljaard (2003). As shown in Table 5.1, all the share equations fulfilled the symmetry assumption.

Table 5.1: Wald Statistics and their corresponding p-values

Restrictions on parameters	Wald Stats	P-Value
Homogeneity in		
Beef share equation	4.12	0.04
Pork share equation	0.60	0.44
Chicken share equation	0.13	0.72
Symmetry for		
Beef and pork price parameters	0.30	0.58
Beef and chicken price parameters	0.51	0.48
Chicken and pork price parameters	0.11	0.75

5.2.2 Result estimates of the Rotterdam model

The parameter coefficients of the Rotterdam model and their corresponding t-values were estimated using a system of equations approach that produces individual equations with their corresponding R^2. Using Equation 4.20, the parameters and the t-ratios of the three sets of equations for beef, chicken and pork were obtained by the restricted seemingly unrelated regression estimation (RSURE) approach, while the method of adding-up recovered that for mutton. SURE modelling was developed by Arnold Zellner in 1962, as a generalisation of linear regression modelling for multiple regression, resulting in simultaneous estimation of several equations with own dependent variable and a set of explanatory variables.

The parameter estimates of the Rotterdam model and their associated t-values are depicted in Table 5.2. Out of fourteen variables, only two variables are significant at a 5% level of significance. Parameters values for mutton were recovered by the adding-up method. Out of fourteen parameters, only three parameters – beef price and chicken price in the beef share equation, and the chicken expenditure in the chicken share equation – were significant at a 5% level of significance. The remainders of the coefficients were insignificant.

The individual R^2 for each equation suggests that if the price of a particular commodity increases, the budget share allocated to the explanatory variable will also increase, leading to a reduction in allocated budget share for other commodities (Paraguas & Kamil, 2005). The system R^2 for the Rotterdam model is 19.1 %. This implies that only 19 % of the variation in the explanatory variable is explained by the independent variables in the Rotterdam model. All estimated expenditure coefficients are positive. The expenditure coefficient measures the change in the i^{th} budget share with respect to change in total expenditure and indicates whether the product is a necessity or luxury. With the exception of chicken, the expenditure coefficients for beef (0.007), pork (0.014) and mutton (0.027) are very close to zero, implying that mutton and pork are normal products in Namibia. For instance in the beef equation, if the price of beef (0.318) increases, consumers allocate more of their meat budget to beef, indicating that beef is a necessity for Namibian consumers. The beef share equation further shows that an increase in the price of chicken (-0.004), pork (-0.003) and mutton (-0.007) reduces their shares in the budget because consumers prefer to spend their income on beef.

The chicken equation indicates that although an increase in chicken price (0.155) increases its share of the budget, it can reduce the budget share for mutton (-0.154), but does not reduce that for pork (0.003).

Table 5.2: The estimated parameters of the Rotterdam model

		Dependent variables			
		Beef	**Chicken**	**Pork**	**Mutton**
Explanatory variables	Beef	0.32** (4.35)			
	Chicken	-0.00** (-0.12)	0.16 (0.56)		
	Pork	-0.00 (-0.08)	0.00 (0.13)	-0.05 (-1.00)	
	Mutton	-0.01 (-0.10)	-0.15 (-0.56)	0.53 (1.24)	0.11
	Expenditure	0.01 (0.70)	0.95** (10.94)	0.01 (2.05)	0.03
	System R^2 =0.19				

The values in parenthesis are the t-ratios.

** indicates significant at 1 % level of significance.

5.2.3 Prices and expenditure elasticities for the Rotterdam model

Table 5.3 below presents the compensated elasticities of demand for the Rotterdam model of Namibian meat data. The expenditure and compensated and uncompensated elasticities for meat products were calculated using Equations 4.27, 4.28 and 4.29, respectively. The compensated elasticities for chicken, pork and mutton are inelastic, while the compensated elasticity for beef depicts a positive sign, implying that beef is price elastic. Beef and chicken own-price elasticities did not satisfy *a priori* expectations of a negative relationship between the quantity demand for a product and prices.

Amongst the compensated cross-price elasticities, half of the coefficients had a negative sign and five of those are statistically significant at 5% level of significance. Pork consumption shows the highest substitution effect in response to mutton price (0.97), followed by the consumption of mutton in response to the price of pork (0.33). The consumption of chicken indicates the weakest substitution to the price of beef (-0.01) and that of pork (0.01). The consumption of beef in response to chicken (-0.01), pork (-0.02) and mutton (-0.02) prices; chicken consumption in response to the price of beef (-0.01) and mutton (-0.03); pork consumption to the price of beef (-0.06); and the consumption of mutton in response to price of beef (-0.92) and chicken (-0.95) are all less than a unit.

With the exception of beef, the absolute values of all own-price elasticities are less than a unity. This could be an indication that chicken, mutton and pork products are not responsive to change in own prices. Out of fourteen elasticities coefficients, only six are statistically significant at a 5% level of significance. The compensated own-price elasticities for beef (1.03) are the most inelastic, followed by mutton (0.68) and chicken (0.35). The pork compensated own-price elasticity (-0.99) is the only coefficient that satisfies the law of demand, indicating that the demand curve for pork has a downward slope.

Unexpectedly, the compensated own-price elasticities for beef (1.03), chicken (0.35) and mutton (0.68) carry positive signs. Theoretically, own-price elasticities should be negative. The positive signed depicted by the compensated own-price elasticities for beef, chicken and mutton are similar to the outcome of the results observed in the study by Paraguas & Kamil (2005) for the Malaysian meat data. The Paraguay & Kamil (2005) study concluded that the estimate obtained from the Rotterdam model was not reliable in estimating meat data from that country.

Table 5.3: Compensated elasticities of the Rotterdam model on Namibian meat data

	Beef	Chicken	Pork	Mutton
Beef	**1.03****	-0.01	-0.06	-1.92**
	(53.95)	(-0.15)	(-0.67)	
Chicken	-0.01**	**0.35**	0.06	-0.95
	(-1.47)	(6.97)	(1.60)	
Pork	-0.02**	0.01**	**-0.99**	0.33
	(-2.22)	(1.60)	(-12.62)	
Mutton	-0.02**	-0.35	0.97	**0.68**
	(-1.27)	(-7.02)	(15.44)	

The values in parenthesis are the t-ratios.

** indicates significant at 1 % level of significance.

According to Taljaard (2003), the uncompensated price elasticities represent compensated price elasticities combined with added effect resulting from the change in relative income on the consumption of a particular product. The results of the uncompensated price elasticities are depicted in Table 5.4. Unlike the compensated own-price elasticities, two of uncompensated own-price elasticities are negative, and the remaining two are positive, which is not in line with econometric *a priori* expectation. Further to that, only five of the coefficients are statistically significant. The uncompensated own-price elasticity for pork (-1.01) is the most elastic, followed by chicken (-0.06). The uncompensated price elasticities coefficients in the Rotterdam model are slightly higher than the compensated estimates.

Table 5.4: Uncompensated elasticities for the Rotterdam model on Namibian meat data

	Beef	Chicken	Pork	Mutton
Beef	**1.03***	-0.67	-0.17	-1.98
	-53.57	(-10.29)	(-1.96)	
Chicken	-0.02*	**-0.6**	-0.1	-1.03
	(-2.45)	(-11.87)	(-2.49)	
Pork	-0.02*	-0.11*	**-1.01**	0.32
	(-2.32)	(-22.46)	(-12.87)	
Mutton	-0.03*	-0.7	0.92	**0.65**
	(-1.45)	(-14.00)	-14.51	

The t-ratios are in parentheses.
* Denotes significant at 1%

Table 5.5 displays the expenditure elasticities for the Rotterdam model as reported. All the expenditure elasticities bear the expected positive signs. With the exception of chicken expenditure elasticities, beef (0.02), mutton (0.17), and pork (0.36) expenditure elasticities are relatively inelastic. Chicken (2.15), on the other hand, has expenditure elasticity greater than one, implying that it is a luxury product in Namibia. The expenditure elasticities for beef, chicken and pork are all significant, as a one per cent level of significance.

Table 5.5: Expenditure elasticities for the Rotterdam model on the Namibian meat data

	Beef	Chicken	Pork	Mutton
Expenditure	0.02* (8.)	2.15* (135.72)	0.36* (34.89)	0.17

The values in parenthesis are the t-ratios.

* indicates significant at 1 % level of significance.

5.3 RESULTS OF THE EMPIRICAL APPLICATION OF THE LINEARISED ALMOST IDEAL DEMAND SYSTEM (LA/AIDS) ON NAMIBIAN MEAT DATA

This section will give a description of the procedures followed to arrive at the results obtained from the regression of the LA/AIDS model on the Namibian meat data. As was done in estimating the Rotterdam model, the parameters for the LA/AIDS model were estimated with homogeneity and symmetry restrictions imposed using the RSURE method. The compensated and uncompensated price and expenditure, and the elasticities for beef, mutton, chicken and pork products were calculated from the estimated parameters.

5.3.1 Testing for restriction on the parameters of the LA/AIDS model

As reported in the literature review, the Deaton & Muellbauer (1980) AIDS model was derived from the utility function. The budget shares for each equation sums up to one. The dependent variables are linearly independent, which implies that there are singularities of the variance of the error terms. The singularity problem was overcome during estimation by dropping one equation, (in this study, the mutton share equation was dropped), and the remaining three share equations, for the beef, chicken and pork equations, were estimated using the SUR. Through the adding-up restriction process, the parameters of the dropped equation were recovered.

The null hypothesis for testing homogeneity in variables is that the sum of price elasticities is equal to zero. An equal increase in the price of the meat product and a consumer's income should, therefore, leave demand unchanged. Homogeneity in the LA/AIDS model is tested on an equation-by-equation basis (Deaton & Muellbauer, 1980). The Wald statistics for homogeneity and the symmetry restriction test, together with their corresponding p-values, are presented in Table 5.6. The homogeneity and symmetry in all the meat share equations are insignificant, indicating that the price parameters are symmetric and homogeneous, of degree zero.

Table 5.6: Wald Statistics and their corresponding p-values for Namibian LA/AIDS meat model

Restrictions on parameters	Wald Stats	P-Value
Homogeneity in		
Beef share equation	0.59	0.44
Pork share equation	1.79	0.18
Chicken share equation	2.51	0.11
Symmetry for		
Beef and Pork parameters	1.93	0.17
Beef and Chicken Price parameters	0.88	0.35
Pork and chicken parameters	0.50	0.48

5.3.2 Results estimates of the LA/AIDS model on Namibian data

The theoretical application of the LA/AIDS model was discussed in Chapter 4. As applied in the Rotterdam model, the monthly time series data from January 2001 to December 2013 for the four meat products, namely beef, mutton, pork and chicken, were used to estimate the LA/AIDS model. The time series data were tested to attest whether they are stationary before being employed in estimating the model coefficients and elasticities, as well as in the testing for the model restriction. The parameters of the LA/AIDS model were estimated using the Seemingly Unrelated Regression (SUR) method.

As was done with the Rotterdam model, the theoretical restrictions, such as symmetry and homogeneity, were imposed during the estimation of the LA/AIDS beef, chicken and pork equations. The parameter coefficients of the model were estimated using Equation 4.39. During the estimation process, the mutton share equation was dropped and the parameters for that equation were recovered by means of adding-up restriction. The parameters of the estimated LA/AIDS model and their corresponding t-ratios are presented in Table 5.7 below.

Table 5.7: The parameter estimates of the LA/AIDS model for Namibian meat products

		Dependent variables			
		Beef	**Chicken**	**Pork**	**Mutton**
Explanatory variables	Beef	0.36			
		(5.18)**			
	Chicken	-0.81	0.20		
		(-1.67)	(3.34)**		
	Pork	-0.09	-0.02	0.14	
		(-3.37)**	(-1.39)	(4.42)**	
	Mutton	-0.19	-0.10	-0.03	0.41
		(-3.55)**	(-2.72)**	(-1.11)	
	Expenditure	-0.12	0.21	-0.03	-0.10
		(-8.77)**	(11.98)**	(-7.07)**	
	System R^2 =0.39				

The t-ratios are in parentheses.
**Denotes significance at 5 % level of significance.

Unlike the Rotterdam model, all three sets of restrictions were satisfied during the regression process of the LA/AIDS model. Nine out of twelve estimated parameters are statistically significant at one per cent level of confidence; one is significant at ten per cent level of significance and only two parameters are insignificant. As stated by Taljaard (2003), this is a good outcome, especially in that time series data were used. Moreover, the real expenditure variables in all meat share equations are significant at one per cent level of significance. The system-weighted R^2 is also higher than that of the Rotterdam model, indicating that the independent variables in the LA/AIDS model explain 39.4 % of the variation in the data.

The budget share for the chicken share equation was the highest, followed by beef, with pork being the lowest. With the exception of chicken, all other expenditure coefficients are negative and significant at one per cent level of significance, implying that beef, mutton and chicken are considered necessity meat products in the Namibian diet. The expenditure coefficient for pork, on the other hand, is positive, and this could be interpreted to indicate that pork is regarded as a luxury product in Namibia. However, Namibia is a net importer of pork meat, and this could have also contributed to the positive sign of the pork expenditure coefficient.

5.3.3 Price and expenditure elasticities for the LA/AIDS model

The system of budget share equations offers a broad characterisation of consumer preferences between goods, and can be used to approximate different types of elasticities, such as own-prices elasticity, cross-price elasticity, expenditure elasticity, and compensated and uncompensated elasticities. The expenditure, and compensated and uncompensated elasticities for meat products were estimated using Equations 4.43, 4.44 and 4.45, respectively. The calculated compensated and uncompensated own price and cross-price elasticities, and their corresponding t-ratios, are presented in Tables 5.8 and 5.9 below, respectively.

Table 5.8: Compensated elasticities of Namibian meat products for the LA/AIDS model

	Beef	**Chicken**	**Pork**	**Mutton**
Beef	**-0.18**	0.12	-1.39	0.29**
	(-972)**	(13.80)**	(-34.25)	
Chicken	0.18	**-0.51**	-1.84	0.21**
	(13.80)**	(-46.23)**	(-72.94)	
Pork	-0.25	0.00	**-0.63**	-0.07
	(-34.25)**	(0.19)**	(-12.88)	
Mutton	-1.41	-1.03	-3.17	**-2.32**
	(-102.92)**	(-155.87)**	(-83.10)	

The values in parenthesis are the t-ratios.
** indicates significant at 5 % level of significance.

As seen in Table 5.8, all own-price elasticities carry a negative sign, which is line with the theoretical expectations. Except for pork and mutton, beef and chicken own prices are both significant at 5% level of significance, while pork and mutton own prices are insignificant. The compensated own-price for mutton (-2.32) is the highest inelastic, followed by pork (-0.63), chicken (-0.51) and beef (-0.18).

The cross-price compensated effect, on the other hand, implies that beef is a net substitute for chicken and mutton, but a complement to pork. Unexpectedly, seven out of twelve cross-price elasticities had negative signs, and only two out of seven variables are statistically significant at 5% level of confidence. According to Taljaard (2003), the cross-price elasticities for substitute products are expected to carry positive signs. Mutton consumption shows the strongest (-3.17) substitute response to the pork price (-0.25), followed by pork (-1.84) for the price of chicken (0.176), while the weakest substitution is that of chicken for the price of beef (0.12).

The uncompensated elasticities for the Namibian meat data are shown in Table 5.9 below. As with the compensated own-price elasticities, all the uncompensated own-price elasticities are in conformity with the *a priori* expected negative sign. Nine of the parameters are statistically significant at 5% level of significance. As for the uncompensated cross-price elasticities, the majority of coefficients have a negative sign, which is not in line with the *a priori* expectations. A rise in disposable income is expected to lead to an increase in meat consumption.

According to Taljaard (2003), a possible explanation for uncompensated cross-price elasticities could be the choices consumers make when there is an increase or a decrease in their disposable income (DI) with regard to the percentage of what to cut out/save on for their savings and expenditure. Taljaard (2003) further elaborated that if income effects were captured, the negative uncompensated cross-price elasticities would indicate that some meat products are complementary. As in case of South Africa, meat is regarded as a normal or luxury product for the larger part of the Namibian consumers. The study by Taljaard (2003) is not the only one that captured unexpected negative signs for the uncompensated cross-price elasticities. A study by Jung & Koo (2002) recorded a similar outcome, although for different meat products.

The uncompensated own-price elasticity of mutton (-1.46) is the most elastic, followed by chicken (-1.16) and pork (-0.65). Beef (-0.36) is the least elastic, indicating that beef is not sensitive to changes in its own price.

Table 5.9: Uncompensated elasticities of Namibian meat products for the LA/AIDS model

	Beef	**Chicken**	**Pork**	**Mutton**
Beef	**-0.36****	-0.33**	-1.517	-0.04
	(-16.95)	(-36.60)	(-37.34)	
Chicken	-0.09**	**-1.16****	-2.02**	-0.26**
	(-4.30)	(-103.82)	(-79.65)	
Pork	-0.28**	-0.08**	**-0.65**	-0.13
	(-37.41)	(-25.44)	(-13.35)	
Mutton	-0.92**	0.15**	-2.84	**-1.46**
	(-28.30)	-21.53	(-73.66)	

The values in parenthesis are t-ratios.

** indicates significant at 5 % level of significance.

Eales & Unnevehr (1994) stated that expenditure elasticities is one of the key determinants of future demand for a product and it is important to obtain an accurate estimate for demand forecasting. The expenditure elasticities for the meat products in the LA/AIDS model are shown in Table 5.10 below. As expected, all expenditure elasticities for the four meat share equations are positive. In addition, the expenditure elasticities for chicken and pork are statistically significant at 5 per cent level of significance.

The estimated expenditure elasticities values for beef, chicken, pork and mutton are 0.60, 1.46, 0.41 and 1.06, respectively. Beef and pork are relatively inelastic, while chicken is more elastic than mutton. The expenditure elasticity results from the LA/AIDS model imply that chicken and mutton are regarded as luxury products, while beef and pork are normal goods in the Namibian food basket. The results further indicate that the consumption of chicken and mutton would not change as a consequence of a change in their respective prices.

Pork has the lowest expenditure elasticity, followed by beef. It can be inferred that pork and beef are considered as necessity products in Namibia. The reasons for beef and pork being necessities could be attributed to traditional beliefs, the availability of those meat types in the market, taste and preferences of consumers.

Table 5.10: Expenditure elasticities of Namibian meat products on the LA/AIDS model

	Beef	**Chicken**	**Pork**	**Mutton**
Expenditure	0.60	1.46**	0.41**	1.06
	(16.31)	(468.66)	(62.01)	

The values in parenthesis are t-ratios.

** indicates significant at 5 % level of significance.

5.4 SUMMARY

This chapter presented the empirical estimation results of the Rotterdam model and the LA/AIDS model, using selected Namibian meat data. The results of the LA/AIDS model for both compensated and uncompensated own-price elasticities produce negative signs, which is in line with theoretical expectation. The Rotterdam model, on the hand, performed better in the prediction of the expenditure elasticities, as all the expenditure elasticities are positive, as expected, and are significant at 1 % level of significance.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

"To wish to progress is the largest part of progress".

- Lucius Annaeus Seneca

6.1 INTRODUCTION

This chapter gives a report of the estimates for Namibian demand for beef, mutton, pork and chicken meat products. The cross-price, own-price and expenditure elasticities of the four meat products under investigation were estimated using SUR method for both the LA/AIDS and the Rotterdam models. Both the Rotterdam model and the LA/AIDS demand model are leading examples of a system-wide approach. The models' simplicity in application has contributed to their popularity and influential role in econometric estimation. The two models were estimated for the selected Namibian meat products and the results were compared to substantiate and choose the model that fits better with the Namibian meat data. The coefficient restrictions, such as the homogeneity and symmetry, were imposed before each model was estimated.

6.2 MODEL CHOICE BETWEEN THE ROTTERDAM AND LA/AIDS MODELS

The analysis in this study was done by estimating the own-prices, cross-prices and expenditure elasticities for the Namibian meat products including beef, mutton, pork and chicken. The results obtained from both the Rotterdam and LA/AIDS models were compare to draw conclusion on which model is the best estimate for the meat demand in Namibia. Before the models were estimated, the Wald test statistics for each of the model were conducted on each meat product. For the Rotterdam model, the Wald test statistics for the beef share equation were significant, which is not in line with the theoretical expectation. In general, when the Wald test statistic is significant, the restriction cannot be imposed on the particular share equation. The parameters of both the LA/AIDS and Rotterdam models were estimated using the beef, chicken and pork data, while that for mutton was dropped during estimation to meet the adding-up restriction. For the Rotterdam model, out of fourteen variables, only two were significant at a 5 % level of significance. Both models were estimated with homogeneity and symmetry restrictions imposed. The parameter values for mutton were recovered by an adding-up method for both the Rotterdam and LA/AIDS models.

Results of the Rotterdam model showed only three out of fourteen parameters – the beef price and chicken price in the beef share equation and the chicken expenditure in the chicken share equation – were significant at a 5 % level of significance. The LA/AIDS model, on the other hand, performed better with nine out of twelve estimated parameters being significant at a 5 % level of significance, while only five parameters were insignificant.

The system R^2 for the Rotterdam model is 19.1 %, while that of the LA/AIDS model is 39.4 %. It can be inferred that the independent variables in the LA/AIDS model explain 39.4 % of the variation in the data, while those in the Rotterdam model only explain 19 % of the variation in the data.

The results of the compensated own-price elasticities obtained from the Rotterdam model for beef, mutton, chicken and pork are 1.03, 0.68, 0.35 and -0.99 respectively. Only pork (-0.99) met the *a priori* expectation of negative compensated own-price elasticities of demand. Unexpectedly, the compensated own-price elasticities for beef (1.03), mutton (0.68) and chicken (0.35) carry positive signs. The compensated own price elasticities obtained from the LA/AIDS model were -0.18, -2.32, -0.63 and -0.51 for beef, mutton, pork and chicken respectively, which all of them meet the *a priori* expectation of negative price elasticities of demand.

The uncompensated own-price elasticity obtained from the Rotterdam model for beef, mutton, chicken and pork were 1.03, 0.65, -0.06 and -1.01 respectively. Like the compensated own-price elasticities, only chicken and pork uncompensated own-price elasticities met the *a priori* expectations of negative own-price elasticities. Similarly to the LA/AIDS compensated own-price elasticities, the LA/AIDS uncompensated own-price elasticity for beef, pork, chicken and mutton were respectively, -0.36, -0.65 -1.16 and -1.46, and all met the *a priori* expectations of negative own-price elasticities of demand.

The expenditure elasticities from the Rotterdam model for beef, mutton, pork and chicken were 0.02, 0.17, 0.36 and 2.15 respectively. While those obtained from the LA/AIDS model were 0.60, 1.46, 0.41, and 1.06 for the beef, mutton, pork and chicken respectively. Interestingly, the expenditure elasticities from both models indicate that chicken is a luxury product for Namibian consumer. However, the LA/AIDS model expenditure elasticities contradict that of the Rotterdam model as it indicated that pork is also a luxury product. These results are not surprising in that the country depends mostly on imported poultry and pork products.

Lastly, all expenditure coefficients for the four meat share equations in the Rotterdam model are positive, and all are significant at one per cent level of significance, while those in the LA/AIDS model are also positive, although only two expenditure coefficients are significant at 5 % level of significance.

Based on the performance of the two models on the selected Namibian meat data, the LA/AIDS model, as compared with the Rotterdam model, performed better in terms of the model's ability to meet the econometric restrictions of homogeneity and asymmetry. The LA/AIDS model also achieved the highest adjusted R^2 of 39% compare to 19% produced by the Rotterdam model. Moreover the LA/AIDS model produced results that are in conformity with the *a priori* expectations in terms of signs of the compensated and uncompensated own-price elasticities. It is therefore concluded that the LA/AIDS models is a better fit for the Namibian meat data.

6.3 RECOMMENDATION FOR FURTHER STUDIES

The literature review showed that the demand estimation approach for use in Namibia has not been given much attention, despite its relative importance. Therefore, there is a need for:

a. Studies to be undertaken that will examine other products in Namibia. This study has included only beef, mutton, pork and chicken meat products, whereas further studies could include other products (such as goat meat) that are equally relevant to Namibian agricultural sector, and the economy as a whole.

b. Better availability of reliable data, which is central to econometric analysis. However, the researcher experienced a problem with data because the series of data used in this study were collected from different offices, which indicates that there is a need for a centralised database for easy accessibility. It is recommended that the Namibia Statistical Agency should collect and keep updated data that are critical for time series analyses.

c. Further econometric studies to be carried out, specifically in the field of agriculture in Namibia. There is need for the Namibian Institute of Science and Technology to fund studies that are related to demand for agricultural products, for both educational purposes and as the basis for policymaking in designing relevant policies not only for the meat industry but other agricultural sectors in Namibia.

REFERENCES

Agricultural Statistics Bulletin, 2000–2009. 2011. Ministry of Agriculture Water and Forestry.. Directorate of Planning. Republic of Namibia.

All Africa Newsletter. 2012. Namibian farmers called to join pork market promotion scheme. 12 July 2012. [Online]. Retrieved from: http://www.pigprogress.net. [17 November 2016].

Adetunji, M.O. and Rauf, M.O. 2012. Analysis of household demand for meat, in Southwest, Nigeria. Ladoke Akintola University of Technology, Ogbomoso Oyo State. Nigeria. [Online]. Retrieved from: http://creativecommons.org. [18 December 2016].

Alston, J.M. and Chalfant, J. A. 1993. The Silence of the Lambdas: A test of the Almost Ideal Demand and Rotterdam models. *American Journal of Agricultural Economics*, *Vol. 75: 304-313.*

Alston, J.M., Foster, K.A. and. Green, R.D. (1994). Estimating Elasticities with the Linear Approximate Almost Ideal Demand System: Some Monte Carlo Results. The Review of Economics and Statistics, Vol. 76, No 2 (May, 1994), pp. 351-356. The MIT Press. [Online]. Retrieved from: http://www.jstor.org. [13 April 2016].

Anwar, A., Aziz, A. and Ali, S. 2012. The Rotterdam Demand Model and its Application to Major Food Item in Pakistan. *Journal of Basic and Applied Scientific Research. 2(5)5081*, 2012. [Online]. Retrieved from: http://www.textroad .com. [10 June 2014].

Asche, F. and Wessels, C.R. 1997. The silence of the Lambdas: A test of the Almost Ideal and the Rotterdam models. *American Journal of Agricultural Economics, Vol. 75: 304-313*.

Barnett, W. A. (1979). Theoretical Foundations for the Rotterdam Model. Federal Reserve Board, Washington Oxford University Press. *The Review of Economic Studies, Vol. 46, No 1 (January 1979), pp. 109-130.* [Online]. Retrieved from: http://www.jstor.org. [07 October 2016].

Barnett, W. A., and Seck O. 2008. Rotterdam Model versus Almost Ideal Demand System: Will the Best Specification Please stand Up? University of Kansas and California State University at Fullerton. 18 May 2007. [Online]. Retrieved from: http://www.ku.edu. [20 June 2016].

Barnett, W.A. and Kalonda-Kanyama, I. 2003. Time-Varying Parameter in the Almost Ideal Demand System and the Rotterdam Model: Will the Best Specification Please Stand Up? Working paper 335. Retrieved from: *Journal of Applied Economics.* [Online]. Retrieved from: http://www.tandfonline.com. [21 November 2016].

Barten, A. P. 1993. Consumer allocation models: Choice of functional form. *Empirical Economics. Volume 18, Issue 1, pp 129–158*. [Online]. Retrieved from: https://www.researchgate.net. [14 December 2016].

Buse, A. 1994. Evaluating the Linearized Almost Ideal Demand System. *American Journal of Agricultural Economics, Vol. 74: 781-794.*

Christensen, L. R., Jorgenson, D. W., and Lau, L.J. 1975. Transcendental Logarithmic Utility Functions. *American Economic Review, 1975, vol. 65, issue 3, pages 367-83.* [Online]. Retrieved from: http://econpapers.repec.org. [6 October 2016].

Clements, K. W., and Gao, G. (December 2014). The Rotterdam Demand Model Half a Century On. Business School, University of Western Australia and Bankwest Curtin Economics Centre, Curtin University. Discussion Paper 14.34. Retrieved from: http://www.business.uwa.edu.au. [19 October 2016].

Cranfield, J. 2012. Canadian Beef Demand Elasticity Study – Final report. Department of Food, Agricultural & Resource Economics. University of Guelph. [Online]. Retrieved from: http://www.cattle.ca/assets. [18 January 2017].

Dakwa T. (2007). The Meat Industry: A Namibian Case Study**.** Research report presented in partial fulfilment of the requirements for the degree of Master of Business Administration**.** University of Stellenbosch. South Africa.

Dameus, A., Richter, F.G.C., Brorsen, W. and Sukhdial, P.K. 2002. AIDS versus the Rotterdam Demand System. A Cox test with Parametric bootstrap. *Journal of Agriculture and Resources Economics. 27(2), pp.335-347.* Western Agricultural Economics Association.

Deaton A., and Muellbauer, J. (1980). An Almost Ideal Demand System. American Economic Review. Vol 70. No 2. (June, 1980) pp. 312-326. American Economic Association. [Online]. Retrieved from: http://www.jstor.org. [06 October 2016].

Delgado, C.; Rosegrant, M.; Steinfeld, H.; Ehui, S.; Courbois, C. 1999. Livestock to 2020: the next food revolution. IFPRI Food, Agriculture, and the Environment Discussion Paper 28. Washington, D.C. (USA): IFPRI. [Online]. Retrieved from: http://hdl.handle.net. [7 October 2016].

Eales, J. 1996. A Symmetric Approach to Canadian Meat Demand Estimation. *Journal of Agricultural and Resource Economics, Vol. 21(2):368-380.* Western Agricultural Economics Association. [Online]. Retrieved from: https://core.ac.uk. [15 June 2016].

Eales, J. S. and Unnevehr, L. J. 1993. Simultaneity and structural change in U.S. meat demand. *American Journal of Agricultural Economics. Vol. 75 (2), pp 259-268.* [Online]. Retrieved from: https://doi.org/10.2307/1242910. [14 December 2016].

Eales, J. S. and. Unnevehr, L. J. 1988. *Demand for Beef and Chicken Products: Separability and Structural Change.* American Journal of Agricultural Economics, Vol. 70, No 3 (Aug., 1988), pp. 521-532. Oxford University Press on behalf of the Agricultural & Applied Economics Association. [Online]. Retrieved from: http://www.jstor.org. [17 October 2016].

Eales, J.S. and Unnevehr, L. J. 1994. The inverse Almost Ideal Demand System. *The European Economic Review, Vol. 38, pp.101-115.* [Online]. Retrieved from: www.farmdoc.illinois.edu. [20 June 2016].

Engle, R. F. and Granger, C. W. J. 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica. Vol. 55, No. 2. (March,1987), pp. 251-276*. [Online]. Retrieved from: http://www.ntuzov.com. [14 December 2016].

Food and Agriculture Organization of the United Nation (FAO). 2013. How to Feed the World in 2050. Economic and Social Development Department. [Online]. Retrieved from: http://www.fao.org. [14 June 2016].

Fujii, E. T., Khaled M and Mak, J. 1987. An Empirical Comparison of Systems of Demand Equations for Tourist Expenditures in Resort Destination. *Philippine Review of Economics and Business. Vol. XXXIV. Nos. 1 & 2, March & June 1987*.

Gai, X. Undated. Testing for Unit Root in Macroeconomic Time series of China. Shan dong province statistical bureau. China. [Online]. Retrieved from: https://www.stat.fi. [11 November 2016].

Green, R. and Alston M.J. 1990. Elasticities in AIDS models. *American Journal of Agricultural Economics*, Vol. 72, No 2, pp. 442-445.

Griffith, G.R., I'Anson, K., Hill, D.J., Lubett, R. and Vere, D.T. (2001), Previous Demand Elasticity Estimates for Australian Meat Products. Economic Research Report No. 5, NSW Agriculture, Orange. [Online]. Retrieved from: http://citeseerx.ist.psu.edu. [10 December 2016].

Holt, T.M. and Goodwin, B.K. 2009. The Almost Ideal Model and Translog Demand Systems. Contributed to *Economic Analysis. Volume 288. ISSN: 05773-8555. JEL classifications: D12*, C32, Q11. [Online]. Retrieved from: https://books.google.com.na. [22 June 2016].

Hupková, D., Bielik, P. and Turčeková, N. 2005. Structural changes in the beef meat demand in Slovakia and demand elasticity estimation. Faculty of Economics and Management. Slovak University of Agriculture, Nitra. Slovak Republic. [Online]. Retrieved from: http://stud.epsilon.slu.se. [7 October 2014].

Jha, R and Sharma, A. 2001. Structural Breaks and Unit Roots: A Further Test of the Sustainability of the Indian Fiscal Deficit. ASARC Working Papers 2001-08. Australia South Asia Research Centre, Australian National University. Canberra. [Online]. Retrieved from: https://crawford.anu.edu.au. [8 February2017].

Jonq-Ying L, Brown, Mark G.; James L. Seale Jr. 1989. Model Choice in Consumer Analysis: Taiwan, 1970-89. *American Journals of Agricultural Economics*.

Jorgenson, D. W. and Lau, L. J. 1975. The Structure of Consumer Preferences. Annals of Economic and Social Measurement. [Online]. Retrieved from: http://www.nber.org. [18 October 2016].

Jung, J. and Koo, W. W. 2002. Demand for Meat and Fish Products in Korea. Selected Paper: Annual Meeting of American Agricultural Economics Association, July 28-31, 2002. Long Beach, California. [Online]. Retrieved from: http://ageconsearch.umn.edu. [15 June 2016].

Lee, J-Y., Brown, M. G., and Seale Jr, J. L. 1994. Model Choice in Consumer Analysis: Taiwan, 1970-89. *American Journal of Agricultural Economics, Vol. 76, No. 3. (Aug.,), pp. 504-512.* [Online]. Retrieved from: http://links.jstor.org. [14 December 2016].

Lombard, H.L. 2013. Price transmission in the beef value chain - The case of Bloemfontein, South Africa. Dissertation submitted for the degree Magister Scientiae Agriculturae in the Department of Agricultural Economics, Faculty of Natural and Agricultural Science, University of Free State.

Luis, M. C., Chris, K., Rocky, F. and Kishore, G. undated. Does Namibia Have A Comparative Advantage In Beef Production? Bush School of Government and Public Service, Texas A&M University.

Meat Board of Namibia 2016. Republic of Namibia. [Online]. Retrieved from: http//www.nammic.com.na. [16January 2017].

Moschini, G. 1995. Units of measurement and the Stone Index in demand system estimation. *American Journal of Agricultural Economics, Vol. 77, No 1 (Feb., 1995), pp. 63-68.* Oxford University Press on behalf of the Agricultural & Applied Economics Association. [Online]. Retrieved from: http://www.jstor.org. [17 October 2016 07].

Mountain, D.C. 1988. The Rotterdam Model: An approximation in variable space econometrics, *Vol. 56, No 2 (March 1988), pp. 477-484.* The Econometric Society. [Online]. Retrieved from: http://www.jstor.org. [07October 2016].

Musaba, E. C. and Namukwambi M. 2011. Socio-economic determinants of consumer fish purchase in Windhoek, Namibia. *African Journal of Agricultural Research, Vol. 6(6), pp. 1483 – 1488*. [Online]. Retrieved from: https://www.researchgate.ne. [18 March, 2011].

Mushendami, P., Biwa, B. and Gaomab II, M. 22 September 2006. Unleashing the potential of the agricultural sector in Namibia. Bank of Namibia. Windhoek.

Mutondo, J. and Henneberry, S.R. 2006. A source of differentiated analysis of U.S. meat demand. Department of Agricultural Economics, Oklahoma State University.

Muzayyanah, U., Maharjan, M.A. and Lall, K. 2011. Livestock products demand in Indonesia: Choosing between AIDS and Rotterdam demand models. *Journal of Indonesian Economy and Business. Vol. 26 Issue 2, p.176.* [Online]. Retrieved from: http://connection.ebscohost.com. [24 September 2014].

Namibia Agriculture Policy. 2015. Ministry of Agriculture, Water and Forestry. Republic of Namibia.

Namibian Census of Agriculture. 2015. 2013/2014 Communal Sector Report. Ministry of Agriculture, Water and Forestry. Republic of Namibia.

Nathinge, I.V.I.N. 2011. Performance of beef exports from Namibia-An econometric analysis. Submitted in partial fulfilment of the Degree Master of Science (Agriculture) in Agricultural Economics. Department of Agricultural Economics. University of Agricultural Science. Bangalore., India.

National Statistic Agency. 2014. Namibia 2011 Population and Housing Census Main Report. Republic of Namibia.

Ogundeji, A.A. 2007. Econometric estimation of armington elasticities for selected Agricultural Products in South Africa. Dissertation submitted for the degree Magister Scientiae Agriculturae in the Department of Agricultural Economics, Faculty of Natural and Agricultural Science, University of Free State.

Osho, G.S. and Asghar, N. 2005. Consumerism: Statistical estimation of Nigeria meat demand: Elasticity (economic evaluation) meat (supply and demand). *Journal of International Business Research.* The Dream Catchers Group.

Overseas Development Institute. 2007. Analysis of the economic and social effects of Namibia's potential loss of current preference to the European Union.111 Westminster Bridge Road, London SE1 7JD, United Kingdom. [Online]. Retrieved from: www.odi.org.uk. [18 January 2017].

Paraguas, M. D. S. and Kamil, A. A. 2005. Model selection of meat demand system using the Rotterdam model and the Almost Ideal Demand System (AIDS). *Journal of Modern Applied Statistical Methods: Vol. 5: Issue. 2, Article 26.* [Online]. Retrieved from: http://digitalcommons.wayne.edu. [21 November 2016].

Pettinger, T. 2011. Different types of goods – Inferior, Normal, Luxury. [Online]. Retrieved from: http://www.economicshelp.org. [15 June 2016].

Piggott, N.E. and Marsh, T.L. January 22-25, 2001. *Impacts of food safety on U.S. meat demand.* Contributed paper at the 45thAnnual Conference of the Australian Agricultural and Resource Economics Society Adelaide, South Australia, January 22-25, 2001. Department of Agricultural Economics, North Carolina State University, and Department of Agricultural Economics, Kansas State University, Manhattan. [Online]. Retrieved from: http://ageconsearch.umn.edu. [09 October 2014].

Pogany, P. May 1996. The Almost Ideal Demand System and its application in general equilibrium calculation. US International Trade Commission. Washington DC. 20436. USA.

Reynolds, R. L. 2005. Alternative Microeconomics, Part II, Chapter 9. Demand and Consumer Behavior. [Online]. Retrieved from: https://cobe.boisestate.edu. [10 July 2016].

Schutz, W. 2009. A Critical Analysis of the Namibian Value Addition Policy With Reference to the Small Stock Marketing Scheme. Meat Board of Namibia. Republic of Namibia.

Scriven, J. (2014). The Impact of Globalization on the Consumer. [Online]. Retrieved from: ttp://www.neumann.edu. [10 July 2016].

Sivaramane N. s.a. Demand models. L.A. S. R. I Library Avenue, Pusa, New Delhi. [Online]. Retrieved from: http://www.iasri.res.in. [17 November 2016].

Slottji, D. 2009. Quantifying consumer preferences. Emerald Group Publishing Limited. Howard House, Wagon Lane, Bingley IWA, UK. [Online]. Retrieved from: http//books.google.com.na. [22 June 2016].

Stone, J.R.N. 1954. Linear Expenditure Systems and demand analysis: An application to the Pattern of British demand. *Economic Journal. September 1954. 64, pp.511-27.* [Online]. Retrieved from: https://www.jstor.org. [23 August 2016].

Strydom, P.J. and Müseler, D.L. 1998. Strategic positioning of the Namibian red meat industry by 2005. *Agrekon, Vol 37, No 4*.

Suruga, T. 1980. Testing the Rotterdam demand model on Japanese expenditure patterns. Osaka University. Japan. [Online]. Retrieved from: http://hermes-ir.lib.hit-u.ac.jp. [25 September 2016].

Svensson, T. H. 2013. The Swedish Demand for food- A conditional Rotterdam model approach. Department of Economics. Swedish University of Agricultural Sciences. [Online]. Retrieved from: http://stud.epsilon.slu.se. [3 January 2017].

Taljaard, P.R. 2003. Econometric Estimation of the demand for meat in South Africa. Dissertation submitted for the degree Magister Scientiae Agriculturae in the Department of Agricultural Economics, Faculty of Natural and Agricultural Science, University of Free State. University of Free State. South Africa.

Taljaard, P.R., Alemu, A.G. and van Schalkwyk, H.D. (2004). A Linearized Almost Ideal Demand System (LA/AIDS) estimation of the demand for meat in South Africa. Contributed Paper Presented at the 41st Annual Conference of the Agricultural Economics Association of South Africa (AEASA). October 2-3, 2003, Pretoria, South Africa. [Online]. Retrieved from: https://www.yumpu.com/en. [21 August 2016].

Taniguchi, K. and Chern, W.S. (2000). Income elasticity of rice demand in Japan and its implications: cross-sectional data analysis. Paper prepared for 2000 AAEA meeting. Food and Agriculture Organizations of the United Nations. Viale delle Terme di Caracalla. Rome, Italy. [Online]. Retrieved from: http://ageconsearch.umn.edu. [6 December 2016].

Taylor, M. R. and Tonsor, G. T. (2013). Revealed demand for country-of-origin labeling of meat in the United States. *Journal of Agricultural and Resource Economics 38 (2), pp.235–47*. estern Agricultural Economics Association. [Online]. Retrieved from: http://www.waeaonline.org. [9 October 2014].

The Namibia Agricultural Union Weekly Newspaper. August 2011. [Online]. Retrieved from: http://allafrica.com. [7 February 2017].

Theil, H. 1965. The information approach to demand analysis. *The Econometric Society: Econometrica.* Vol. 33, No. 1 (Jan, 1965), pp. 67-87. [Online]. Retrieved from:http://www.jstor.org. [15 June 2016].

World Bank. 2012. Livestock competitiveness, economic growth and opportunities for job creation in Namibia: A policy note. Poverty Reduction Economic Management Southern Africa Region. [Online]. Retrieved from: http://www.the-eis.com. [06 October 2016].

Worldmap.com. s.a. [Online]. Retrieved from: https://www.google.com. [02 February 2017].

Xu, X. and Veema, M. 1995. Model choice and structural specification for Canadian meat consumption. Department of Rural Economy, University of Alberta, Edmonton, Alberta, Canada. [Online]. Retrieved from: http://erae.oxfordjournals.org. [06 October 2014].