Estimation of supply response and elasticities of broiler meat in South Africa

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Dissertation accepted in fulfilment of the requirements for the degree Master of Science in Agricultural Economics at the North West University

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Graduation ceremony: October 2023

DECLARATION

I hereby declare that this dissertation is my original work and has not been previously submitted for a master's degree at another university. When other people's work has been used, it has been properly recognised in this text.

DEDICATION

I am dedicating my thesis to my family. A special feeling of gratitude and support goes to my caring and loving wife, Mavis Kgomotso Mmila, my late father, Mbeke Frans Mmila and my elder brother, Robert. I also dedicate this thesis to my Church of Christ Assemblies family for their help and encouragement during the writing process. I will always be grateful for the spiritual transformation through the church and the angel and prophetess, Mother Cathrine Mmamodisa Ngcelwane.

ACKNOWLEDGEMENTS

I am grateful for the help of my supervisor, Professor Simon Letsoalo, for his guidance and expert advice during this study. He played a crucial role in the organisation of this thesis and contributed incredibly through his insightful comments. Secondly, my appreciation goes to my co-supervisor, Mr Usapha Luvhengo, for providing direction, and assistance in ensuring that this project was completed. Besides, my acknowledgements go to the North West University Post-Graduate Bursary for financial assistance when I could not afford to pay for my studies.

Also, my special acknowledgement and appreciation go to the South African Poultry Association (SAPA) and South African Reserve Bank (SARB) for providing secondary data for my research. I am fortunate to have had this support during my research because the success and completion of this project required a lot of direction and assistance.

I also want to thank my family and friends, without whom I would not be the person I am today. They have been so encouraging over the years. Moreover, I want to express my gratitude to my wife, who sacrificed a lot to give me the chance to study for such a long time, as well as to my children for their unwavering support and assistance. Last but not least, I would want to express my sincere gratitude to anyone who helped me with this dissertation, directly or indirectly.

ABSTRACT

This study examined the nexus between broiler supply and macro- economic variables such as price and non-price factors over the period 2010 to 2021. Low-cost chicken products have entered the market as a result of trade agreements and market conditions, putting downward pressure on local pricing and reducing market share for South African producers. South African broiler meat producers have been unable to propel the industry forward. Thus, the main aim of the study was to estimate the supply response and price elasticity of broiler producers in South Africa.

Secondary data used in this study were obtained from the South African Poultry Association (SAPA) and the South African Reserve Bank (SARB). Data on broiler supply, broiler imports and exports, broiler feed price index, and weighted average broiler price were obtained from the South African Poultry Association (SAPA). Data on the nominal exchange rate were obtained from the South African Reserve Bank. Econometric techniques of ARDL were used to analyse broiler supply as an dependent variable, while the log of broiler imports (lbim), exports (lbex), broiler feed price index (lbpi), log of weighted average broiler price, (labp) and nominal exchange rate (ner) and (D) dummy (diseases) are the explanatory variables.

These variables were integrated into distinct orders, in a combination of both I (0), I(1), order which made the ARDL cointegration technique the preferred model for analysis. In identifying variables that affect the supply response of broiler producers, the study found that Weighted average broiler price, (labp) was the only variable that was significant at (p<0,005) in the long run but inelastic at 0.3417 in the long run. The other variables were found to be insignificant. The p-values for the independent variables were found as follows; Broiler feed price index, (0.982) broiler imports (0.524) and exports (0.640), a nominal exchange rate (0.598) and disease (0,976) which indicate that these variables as individuals have no significant effect on the supply of broilers in the long run. However, diseases were found to be significant, with a p-value of 0,020 in the short run. This indicates that diseases have a significant effect on the supply of broilers in the short run. Collectively, all these variables (log of broiler imports (lbim), exports (lbex), broiler feed price index (lbpi) and nominal exchange rate (ner) have a significant effect on the supply of broilers in the short run with a p-value of 0.020. The study found that the previous supply of the broiler significantly at (p<0,005), decreases the current supply of broilers in the short run by 0.7225.

The study found that broiler price elasticity of supply is 0.3417 in the long run, but -0.1026 in the short run is not significant in the short run. In either period, the elasticity of broiler price in relation to the supply of the broiler is inelastic in the long run. This implies that a 1% increase in the price of the broiler results in a less proportionate increase in the supply of the broiler. The supply response of broiler producers is mainly affected by the price of the broiler and also by non-price factors collectively.

The study recommends that the Department of Agriculture, Land Reform and Rural Development, South African Reserve Bank and Department of Trade, Industry and Competition should strengthen their efforts in stabilising broiler meat prices, as broiler meat is the cheapest source of protein and it is affordable by many poor households in South Africa. Department of Agriculture, Land Reform and Rural Development should ensure that necessary reforms in the poultry industry are realised through the implementstion of the poultry master plan.

Keywords: Broiler, Broiler producers, Supply Response, Price elasticity of supply, ARDL, Partial Nerlovian Model

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AGOA - African Growth and Opportunity Act

ARDL- Auto regressive Distributed Lags

BFAP- Bureau for Food and Agricultural Policy

COVID 19- Coronavirus Disease

CUSUM- Cumulative sum of recursive residuals

DAFF- Department of Agriculture, Forestry and Fisheries

DALRRD- Department of Agriculture, Land Reform and Rural Development

DTI- Department of Trade and Industry

ECM- Error Correction Model

EU- European Union

FAO- Food and Agriculture Organisation

HPAI- Highly Pathogenic Avian Influenza

ITAC- International Trade Administration Commission of South Africa

IQF- Individually Quick Frozen

IDC- Industrial Development Corporation

NAMC- National Agricultural Marketing Council

SADC- Southern African Development Community

SAPA- South African Poultry Association

SARS- South African Revenue Services

OECD- FAO - Organisation for Economic Cooperation and Development – Food and Agriculture Organisation

OLS- Ordinary Least Squares

USA- United States of America

USDA- United States Department of Agriculture

US- United States

VAT- Value Added Tax

VIF- Variance Inflation Factor

1 CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The broiler industry remains the biggest subsector of agriculture in South Africa in terms of the value of production (Department of Agriculture Land Reform and Rural Development, 2020). The most economical meat alternative is still broiler meat, which is crucial for ensuring household food and nutrition security as well as the stability of the South African food system (Mchiza *et al.*, 2015). The South African poultry business would be considered a strategic industry with a significant contribution to food security in South Africa given that chicken dominates the country's meat market and serves as consumers' preferred and inexpensive source of protein (Davids *et al.*, 2015).

According to Department of Agriculture Forestry and Fisheries (2018), the industry generated about R40 billion of the agricultural gross value which accounts for 15.6% of the total gross value of agricultural products in the year 2017. The contribution of animal products to the total gross value was 49.2%, followed by horticultural products at 30.3% and field crops at 20.5%. A large portion of the animal product contribution comes from the broiler industry at 16.8%, followed by slaughtered large stock at 12.5% and lastly, maize at 7.4%. In 2018, R46.5 billion in agricultural gross value was generated by the broiler industry, which was about 16.5% of the total gross value of 33% of all animal products. (Department of Agriculture Forestry and Fisheries, 2019).

Consumption and production of broiler diverge over time, resulting in South Africa becoming a net importer of broiler meat; the consumption of broiler meat as a source of protein exceeds that of other varieties of meats (Department of Agriculture Land Reform and Rural Development, 2020). There has been an increase in the consumption of broiler meat in South Africa, which exceed what is produced, and this indicates that as a country, we are not self-reliant, and imports are critical to sustain the local demand for broiler (Department of Agriculture Land Reform and Rural Development, 2020). According to Bisschoff and Liebenberg (2017), consuming more fast food, particularly chicken restaurants, South Africans boosted their meat consumption. Since 2014, the amount of chicken consumed in fast food has increased by about 3% annually, and it is

predicted that by 2018, 42% of people will consume chicken takeout on a monthly basis (up from 29% in 2014).

South Africa as the net importer of broiler products is affected by variations in the global markets such as exchange rates and low feed costs from other countries. These changes influence the industry to gain insight into the performance of the South African market within the circumstances of the foreign markets (De Beer, 2010). Figure 1.1 indicates that from 2009 to 2018,

Figure 1.1 Broiler meat exports and imports

Source: (Department of Agriculture Forestry and Fisheries, 2019)

five hundred and thirty-seven thousand (537 000) tonnes of broiler meat were imported at an estimated value of R6 billion. The shows that there has been a significant increase from 2009 to 2018. This increase is due to increasing consumption coupled with stagnant production levels in South Africa. Also, diseases such as Avian Influenza have a negative impact on the levels of imports. In 2017 and 2018, there was a drastic decline in the importation of broiler meat from European Union which was due to the outbreak of Avian Influenza in December 2016, resulting in the banning of imports from the European Union (EU) (Department of Agriculture Forestry and Fisheries, 2019). This is indicated in Figure 1.2

Figure 1.2 Broiler meat imports

Source:(Department of Agriculture Forestry and Fisheries, 2019)

Profit margins in broiler production are affected by feeds cost, which constitute 75% of the entire cost of production. Profit margins remain volatile due to occasional changes in soybean meal, and there exists the constraint of incorporating the prices of maize in that of chicken meat and eggs (Nkukwana, 2018). Feed outlay remains the key driver of higher production costs of the broiler. However, during a good harvest of maize in South Africa, feed costs are relatively cheaper than in Europe (South African Poultry Association 2017).

The outbreak of the extremely pathogenic H5N8 virus in South Africa exerts a remarkable impact on the poultry industry. The country's strategy to put the disease under control has been the culling of the affected sites. The initial total cost reported was R40.5 million as of the 8th of December 2017 (Bureau for Food and Agricultural Policy, 2018A).

1.2 Problem Statement

Meat consumption has expanded quickly in South Africa as a result of consistent economic growth and rises in the average income (Poultry world, 2015). With an increase in disposable income, South Africans' preference for meat is reflected in their purchasing patterns. Due to its low cost and wide availability, broiler meat has developed into the most significant source of protein in the diets of the majority of South Africans (United States Department of Agriculture, 2015).

South Africa has been an increasing net importer of broiler meat because exports of broiler were far less than imports. This might have been aggravated by the imports of certain pieces of broiler

from the United States of America (USA), Brazil and the EU into the South African market (Department of Agriculture Forestry and Fisheries, 2019).

According to South African Poultry Association (SAPA), the EU dumps subsidized poultry meat into the nation through its economic partnership agreements (EPA), with disastrous effects on local industry production. The government, meat importers, and the EU, according to SAPA, continue to make this claim although there is information from a few studies that contradicts it. Despite the conflicting opinions, the local poultry sector is adamant that imports subject it to unfair competition and has asked for protection in the form of tighter tariff restrictions (National Agricultural Marketing Council, 2020), hence the Department of Trade and Industry (DTI) has categorized this industry in distress as domestic broiler producers are unable to compete at levels dictated by import prices. Local broiler production has stagnated due to other factors such as broiler import increase and drought conditions which push feed prices high. This raised concerns about the sustainability of the industry and requires a critical evaluation of the factors that drive competitiveness (Davids & Meyer, 2017).

Since 2010, rising imports higher than domestic production have accounted for an increasing portion of the expansion in chicken consumption. While the broiler industry's significance for the South African agricultural sector cannot be disputed, concerns about its long-term viability are raised by its failure to compete in the global export market and against surplus broiler (Bureau for Food and Agricultural Policy and National Agricultural Marketing Council, 2019).

In addition, there are barriers to entry in the industry that inhibit small-scale producers to enter the markets. Such barriers include economies of scale benefits and large capital requirements to entry (Louw *et al.*, 2011). More so, the broiler industry in South Africa is currently facing trouble given that feed prices have increased significantly since 2010, and this increase has not been echoed by the price of broiler meat.

Although the South African government has invested in and supported the value chain for broiler, Brazil's support (main exporter to South Africa) has been more substantial. For instance, the Brazilian government provides technical assistance to players in the sector while simultaneously subsidising credit for investment in the area, unlike the South African government, which has invested directly in new businesses through the Industrial Development Corporation of South Africa (Valdes *et al.*, 2015).

1.3 Significance of the study

Since broiler meat is the cheapest source of protein and its consumption is increasing in South Africa, the industry is the pillar of the agricultural economy in creating more jobs. The stability of the poultry sector is imperative to the South African economy. Broiler producers as part of the value chain in the industry play a critical role in terms of supplying broilers meat. Factors affecting the supply of broiler meat will be assessed, including how broiler meat producers respond to the changes around these factors. The study analysed the extent to which these factors affect the supply response. Therefore, information about the responsiveness of broiler producers to changes in non-economic and economic contributing determinants can assist government and policy makers in structuring and formulating policies and strategies that are imperative to the stability, growth, and sustainability of the poultry industry.

1.4 The aim of the study

The main aim of the study was to estimate the supply response, and price elasticity of the broiler and assess the relationship between the variables. This study was done to explore how broiler producers respond to variations in the prices of the broiler and other factors and the effects of these changes on the supply of the broiler in South Africa. Furthermore, the study assessed short- and long-term relationships between variables.

1.4.1 Research Questions

1. What are the main factors that affect the supply response of broiler meat in South Africa?
2. What is the supply response of broiler farmers to changes in price and non -price factors?
3. What are the short- and long-term price elasticities supply of broiler meat in South Africa?

1.4.2 Objectives of the Study

- To quantify the supply response to changes in broiler meat prices in South Africa.
- To estimate the supply response of broiler producers to changes in price and non-price factors.
- To determine the price elasticity of the supply of broiler in the long and short run.

1.5 Delineation

This study was conducted in South Africa covering all nine provinces. The study is delineated to the population of commercial broiler producers in South Africa.

1.6 Hypotheses

H_0 : Supply response of broiler meat in South Africa is not influenced by price.

H_1: Supply response of broiler meat in South Africa is influenced by price.

H_0 : Supply response of broiler meat in South Africa is not influenced by non- price factors.

H_1: Supply response of broiler meat is influenced by price by non-price factors.

1.7 Scope of the study

The study seeks to estimate the supply response and price elasticity of broiler in South Africa. Furthermore, the study assessed the relationship between variables, whether there is a short term or long-term relationship. The study focused on commercial broiler producers in South Africa using published data from commercial producers of broiler. Secondary data used in the study were from 2010 to 2021. The study did not focus on small-scale broiler producers, as their data were not part of the time series data on broiler from the South African Poultry Association (SAPA).

1.8 Ethical considerations

The underlying ethical concerns surrounding the secondary use of research data are still there, but they are now more urgent due to the development of new technologies. Data compilation, storage, and sharing have all gotten considerably quicker and simpler (Tripathy, 2013). Time series data on broiler were obtained from the South African Poultry Association (SAPA) which has the mandate to establish a suitable statistical database. SAPA has valid and credible methodologies for data collection from commercial broiler producers. Data were made available on request, based on the North West ethics clearance approval.

1.9 Outline of the study

This study covers five chapters, excluding References. Chapter One of the study covers the background of the study, problem statement, objectives of the study, hypothesis and significance of the study. Chapter Two (Literature Review) covers an overview of the broiler industry,

international, South Africa and Southern African Development Community (SADC)level, factors that affect the supply response of the broiler in South Africa, supply and elasticity theory, agricultural supply response theory, econometric models for supply response and recent studies on the supply response. Chapter Three (Research Methodology) covers the description of the study, data collection, techniques for data analysis, diagnostic tests and data analysis software. Chapter Four (Results and Discussion) covers descriptive analysis, unit root test results and lag length selection criteria, diagnostic test results, ARDL test results, bound test results and CUSUM stability test results. This chapter also includes a discussion of results. Chapter Five (Conclusion and Recommendations) covers conclusion and recommendations.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The objective of this chapter is to give an overview of the broiler industry at the international, national (South Africa) and SADC levels, key factors affecting the broiler industry, particularly supply response by producers and a theoretical review of key concepts such a theory on production economics, supply and elasticity, supply response, supply shifters and econometric methods that support the analysis of supply response. The international overview of the broiler industry is discussed as developments at that level have impact on the functioning of the South African broiler markets. South Africa as part of SADC makes an impact on the SADC broiler markets and as such, its central role needs to be acknowledged. This chapter included a critical analysis of the South African broiler industry, as it provides the cheapest source of protein and how this sector is affected by international markets and other policy priorities. Furthermore, the emphasis is on key concepts and how they relate to the research topic. The literature review is done on supply response and appropriate methods of analysis in terms of supply response.

2.2 International Broiler Industry Overview

It is crucial to comprehend how the South African broiler market functions in relation to other markets across the world. Changes in the global broiler market will have an impact on the South African broiler industry because the country is a net importer of chicken (De Beer, 2010).

In recent years, poultry meat has been the type of meat that is most frequently produced. Poultry accounts for 40.6% of the world's 337.3 million tons of meat produced in 2020. According to the Food and Agriculture Organisation (2021), there are approximately 27.9 billion heads of poultry in the globe as of 2019. This includes chicken, duck, goose, guineafowl, and turkey. With around 93% of this presence, chickens hold the largest part. Poultry production, particularly broiler production, is anticipated to help Africa's urgent demand for animal protein due to its capacity to provide food and livelihood security (Abu Hatab *et al.*, 2019; Paswan *et al.*, 2014).

Figure 2.1 indicates that there has been an exponential growth of global broiler production from 2010 to 2021. This figure shows some moderate fluctuations which could be because of natural and macro-economic effects. According to Figure 2.1, in 2021, 100 000 metric tonnes of broiler were produced as compared to 77 000 metric tonnes produced in 2010. The figure indicates that

a 23% increase in the production of the broiler was recorded between 2010 and 2021. According to Alltech (2019) in 2018, the production of broilers increased by about 3% worldwide. All regions had growth, except Latin America, which saw a very slight dip. Africa experienced 9% growth, illustrating the general tendency that as populations expand and get wealthier, so does interest in protein, especially delectable chicken.

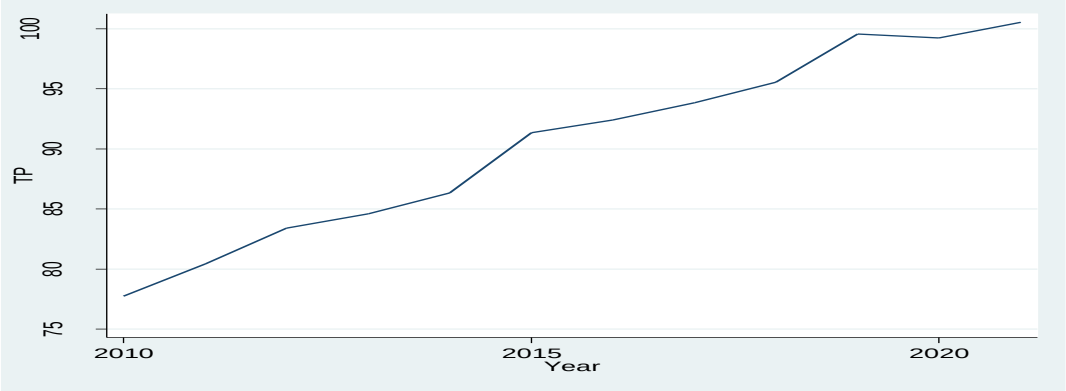

Figure 2.1 Global Broiler Production

Source: (United States Department of Agriculture, 2022b)

2.2.1 Major Broiler Producers

The highest-producing country is the USA, and the EU is ranked the fourth highest, with China and Brazil ranked second and third respectively. In 2016, Brazil became the second-highest country in broiler production, with China becoming the third country. Brazil's currency devaluations have benefitted the agricultural trade, which help explain why with every recession, Brazilian agriculture becomes more export oriented. Brazil's total merchandise exports climbed 6.7% between 2015 and 2019 in response to the devaluation, while total imports fell, reflecting the general downturn of the local economy (Valdes *et al.*, 2020). The USA broiler production is concentrated in a few states because of agro-climatic conditions that favour broiler production. The top five broiler-producing states are Georgia, Arkansas, Alabama, Mississippi, and North Carolina; together they account for around 60% of total broiler production in the United States (EconomicResearchService, 2004). The USA broiler meat production is from 25 000 family farmers with production contracts with companies, and these farmers contribute 95% of the USA production and the remaining 5% from company-owned farms (NationalChickenCouncil, 2021)

According to Figure 2.2, the global production of the broiler was estimated at 77,729 metric tons, with the USA (16.563) leading in terms of production, followed by China (12.550), Brazil (12.312) and the EU (9.202). According to Figure 2.2 there has been an increase in the broiler with moderate fluctuations. Ninety-one thousand, three hundred and fifty-nine (91 359) metric tons of broiler were produced in 2015, and the USA was also a leading country, and even in 2020, the status was the same.

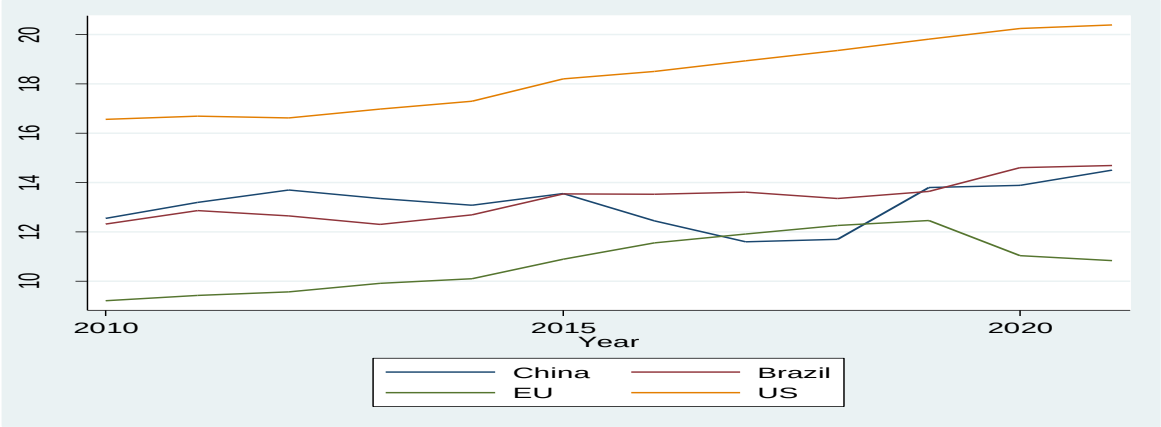

Figure 2.2 Major broiler producers

Source: (United States Department of Agriculture, 2022b)

In 2015, the value of the world's compound feed industry was estimated at 450 billion United States dollar (USD), with output totalling 996 million metric tons. The production of industrial feeds worldwide is made up of 463 million metric tons, or 47%, by the poultry compound feed business (Alltech, 2016). Feed prices have been extremely variable over the past ten years, peaking in 2008, mostly due to rising demand from developing nations and competition with the production of renewable energy from biofuels (Godfray *et al.*, 2010).

The eighth edition of the yearly study comprises data from 144 countries and approximately 30 000 feed mills, and it forecasts that global feed tonnage has climbed by a significant 3% to 1,103 billion metric tonnes produced in 2018, topping one billion tonnes for the third consecutive year. Over the last five years, the feed business has grown by 14,6% or an average of 2,76% per year. The middle class is expanding along with the population, which is shown in the rise in global protein consumption. China, the United States, Brazil, Russia, India, Mexico, Spain, and Turkey are the top eight producers of animal feed (Alltech, 2019).

Because feed prices make up roughly 70% of the overall cost of chicken production systems, countries with access to inexpensive feeds have an advantage. Secondly, advanced technology in developed countries plays a critical part in ensuring that production becomes efficient (PhytoBiotics, 2021). Since these two factors are key in terms of broiler production, it can be concluded that developed countries contribute a lot to global broiler production.

Without any doubt, the USA broiler sector has been a technological and commercial pioneer. One of its most significant accomplishments is the establishment of contract farming and vertically integrated production methods, which are now commonplace in the global broiler business (Martinez, 1999; Ollinger *et al.*, 2000).

2.2.2 Global Broiler exports and imports

Global poultry imports rose between 2001 and 2021, as these markets' demand for poultry products climbed. Over the next ten years, poultry is anticipated to continue being the most widely imported livestock product by volume. Since 2001, the import of meat, especially poultry, has increased dramatically. Between 2001 and 2021, total imports of livestock products, including beef, pig, and poultry, increased by 117%, and they are expected to continue to rise through 2031 (United States Department of Agriculture, 2022a).

According to the United States Department of Agriculture (2022b) (United States Department of Agriculture, 2022a), as shown in Figure 2.3 global imports of poultry increased by an average of 4% per year between 2001 and 2021, reaching 14.2 million metric tons. By 2031, the United States Department of Agriculture(USDA) expects poultry imports to reach 17.5 million metric tons. By contrast, it is anticipated that beef imports will climb to 14.3 million metric tons, and pork imports will reach 14.8 million metric tons by 2031.

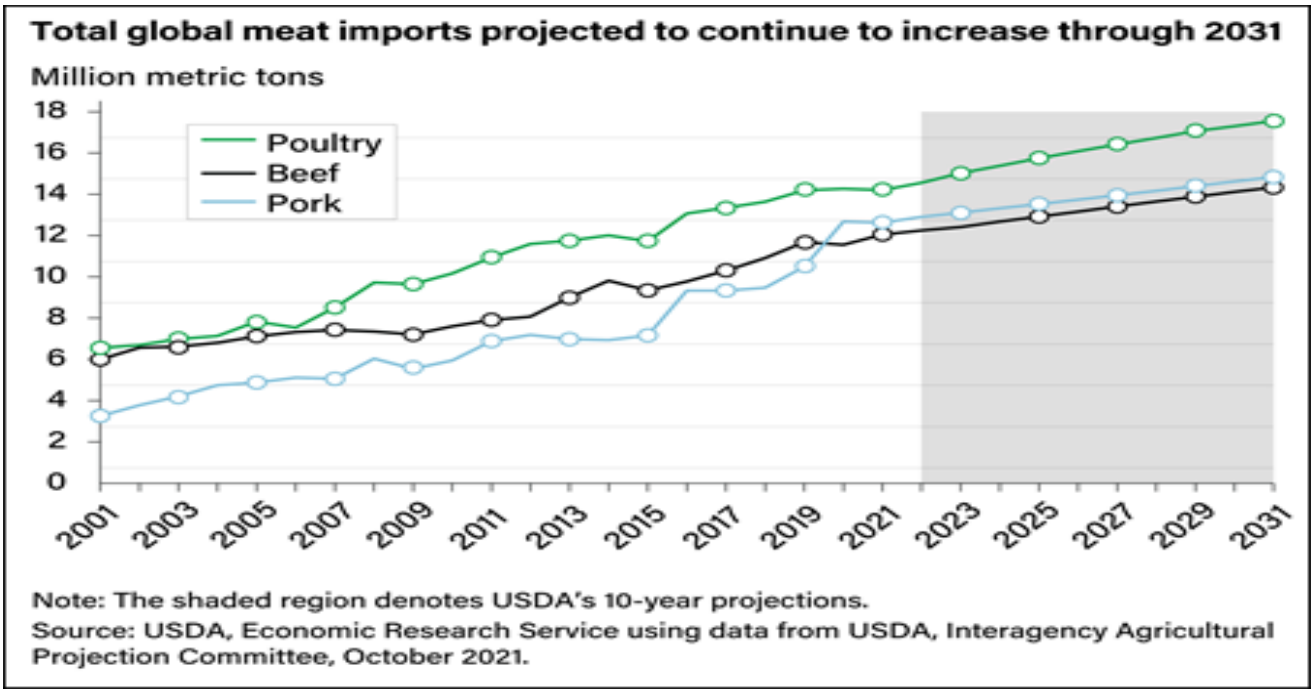

Figure 2.3 Global meat imports

Source (United States Department of Agriculture, 2022a)

According to the Agriculture (2022), United States Department of Agriculture (2022b), Brazil, the USA, and the European Union are the top three exporting nations in terms of volumes of meat. Together, they made up 71% of poultry exports globally in 2021, and by 2031, that figure is expected to mostly hold steady. Then, 19% of global poultry exports in 2021 came from the other four major exporting regions of "Other Latin America," "Other Asia," Thailand, and the former Soviet Union. By 2031, their market share is anticipated to marginally rise. Between 2001 and 2021, Brazil's exports of chicken increased quickly, and in 2007, it reclaimed the top spot in the international export rankings. Brazil's poultry output is anticipated to increase by 3% to 14.85 million metric tons in 2023 as a result of robust international demand and increased domestic consumption (The poultry Site, 2022).

Forecast consumption for 2023 is 9.85 million metric tons, an increase of 2%. Brazilian exports of chicken meat are anticipated to remain the highest in the world, and post projects a 6% increase to 5 million metric tons in 2023 (The poultry Site, 2022). Brazil's rise in chicken production was aided by increased domestic production of poultry feed (feed grains and soybeans) (United States Department of Agriculture, 2022a).

China is predicted to remain Brazil's top export market for chicken, accounting for 34% of total output overall. The rapidly rising input costs, which rose from 5-20% of output in the period from January to July 2022, affected poultry pricing (The poultry Site, 2022).

2.2.3 Global Broiler Consumption

Due to an increase in population and affluence over the past few decades, there has been a steady rise in the consumption of meat (Organisation for Economic Co-operation & Development, 2018). With increased purchasing power, consumers have switched from diets high in grains to those higher in meat. The output of all types of meat has increased, but since the 1960s, the production and consumption of chicken have grown more quickly (Organisation for Economic Co-operation & Development, 2018).

According to Kwadzo *et al.* (2013), the first stage to strategically situate the domestic chicken business to compete effectively with import replacements is understanding consumer preferences on characteristics of broiler meat. Consumption of meat has shifted to include more poultry. This reflects the cheaper cost of chicken as compared to other meats in developing nations with lower levels of income, while it shows a growing preference for white meats in high-income nations since they are easier to cook and seen as healthier food options (Food and Agriculture Organisation, 2021).

Production and consumption of poultry have both increased quickly globally. Short production cycles, numerous cooking options, minimal fat content, and affordable prices as compared to beef and pork are some of the factors driving this expansion. A small number of nations dominate the global broiler trade, and broiler markets are extremely concentrated in terms of production (Rogowsky Robert & Simpson, 1998).

White Chicken meat (breast meat) has more preference in countries in the northern hemisphere and based on this research and development in countries like the USA and European Union (EU) have produced more broiler meat. Surplus of brown meat (drumsticks and thighs) was realised, and exported to global markets. As a result, there was an increase in imports in the South African broiler markets, and this was also aggravated by trade agreements between the USA and EU countries. According to Salin *et al.* (2005), consumers in the USA and Canada favour white meat more than those in Mexico and Brazil. This great desire for white meat also keeps the price of dark

meat stable in the USA and Canada. One of the main drivers of American exports is the low price of dark meat.

According to projections by the Food and Agriculture Organisation (2021), the average global consumption of animal proteins during the following ten years will rise by 14% by 2030, primarily due to income and population growth.

The trends in the consumption of chicken meat worldwide from 2017 to 2022 are depicted in Figure 2.7 . Between 2017 and 2021, the consumption of chicken meat worldwide increased at a Compound Annual Growth Rate (CAGR) of 0.04 percent. Consumption of chicken meat increased globally by 1.4 percent, from 87.8 million Metric Tonnes (MT) in 2020 to 89.1 million metric tonnes (MT) in 2021. The consumption of chicken meat will rise by 0.5 percent to 89.5 million MT in the world in 2022. Increased demand, among others, in the USA (0.4%), the EU (0.6%), and Russia (3.4%) will contribute to the expansion in global consumption (Landbank, 2022).

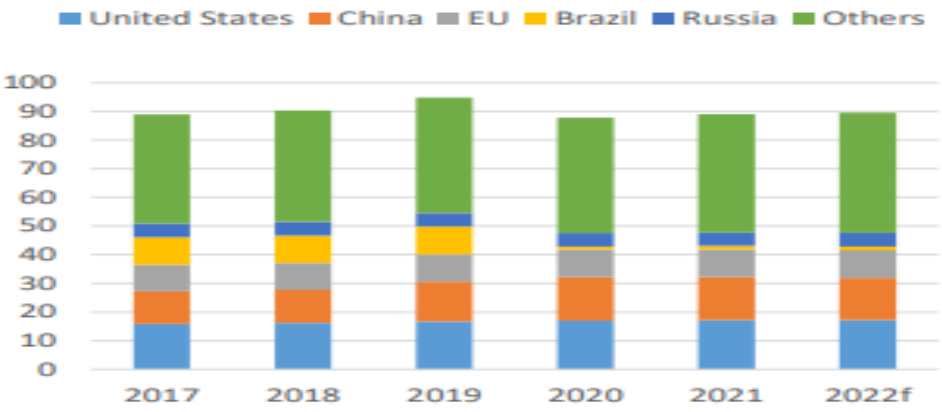

Figure 2.4 Top 5 chicken meat consuming countries Million (MT)

Source: (Landbank, 2022)

According to Food and Agriculture Organisation (2010), broiler consumption worldwide has quadrupled since 1960 from 3kg to 11kg in 2003. The USA is the largest broiler meat consumer at 17.7%, China at 13.2% and Brazil at 10.5% (FairPlay, 2018). Per Capita Consumption of broiler meat in USA is expected to increase by 93.2 pounds in 2019 (Shahbandeh, 2019). South Africa as the small player in the broiler market globally, consumes only 1.7% of the global consumption with a contribution of about 1.7% of the total broiler production in the world between 2013 and 2015(Organisation for Economic Cooperation and Development and Food Agriculture Organisation, 2016)

Poultry production in USA is the largest and the second exporter of poultry meat in the world, according to the Economic Research Services (ERS) of the United States Department of Agriculture (United States Department of Agriculture, 2016).

2.2.4 Global Broiler Market Share

Broiler meat is one of the most important meats on the worldwide market, and it is now the second most consumed meat in the world (Food and Agriculture Organisation, 2007). The fastest-growing agricultural sub-sector, particularly in emerging nations, is the chicken industry, which plays a crucial role in food safety and nutrition. Future expansion of the sector is anticipated to be influenced by variables like population increase, income level growth, and urbanisation.

The poultry industry is anticipated to rise from its current market size of $ 310.7 billion in 2020 to $ 322.55 billion in 2021, with a compound annual growth rate (CAGR) of 3.8%. With a CAGR of 7%, the market is anticipated to reach $ 422.97 billion in 2025. COVID-19 impact and restructured their operations will be the main drivers of growth in 2021. Due to constraints, including social isolation, remote employment, operational challenges, and ceased commercial activity, the Covid-19 pandemic has made the sector go through a challenging period (Yıldız, 2021).

Resource endowment (as indicated by, among other things, agro-climatic conditions, cost and availability of critical inputs, consumer preferences, and government policies) has the greatest impact on the global broiler market structure. Given that broilers are sensitive to fluctuations in temperature and humidity, ensuring optimal output would necessitate that these conditions be intrinsically beneficial to reduce the expense of disease control and the environment. Furthermore, because feed costs account for roughly 70% of the overall cost of intensive poultry production systems, the availability of low-priced feeds is one of the most critical variables influencing industry growth (Chang, 2007).

For example, USA and Brazil, the world's two most efficient broiler producers, are also large grain producers. Broiler industries in major exporting countries are characterised by sophisticated technologies and a high level of vertical integration (WorldPoultry, 2004a). Domestic and international government policies have a substantial impact on industry development and trade flow. Various degrees of trade and government intervention, such as tariffs, quotas, import taxes, and subsidies, still exist despite the World Trade Organisation (WTO) and other regional trade

accords. These obstacles have a significant impact on the functioning of the poultry industry in some Western and Asian countries.

Below is the global broiler market share indicating that between 2006 and 2015, the USA had the highest broiler market share, followed by China.

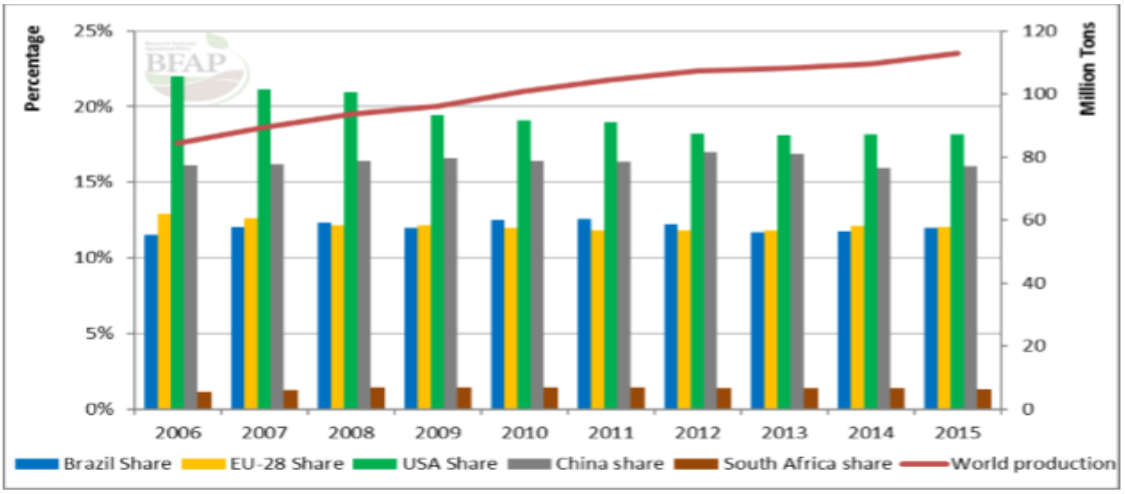

Figure 2.5 Global broiler market share

Source: (Bureau for Food and Agricultural Policy and National Agricultural Marketing Council, 2019)

Globally, poultry meat production, consumption, and trade have increased faster than any other meat in recent decades. Because poultry meat is less expensive, more adaptable, and has more health benefits than other meats, this trend is predicted to continue. Broiler meat is the cheapest and most popular poultry product on the market around the world. Contract farming and vertical integration, which are fundamental characteristics of the world's most efficient broiler producers, have resulted in increased production, more efficient marketing, and a greater range of value-added products at reduced costs (Chang, 2007).

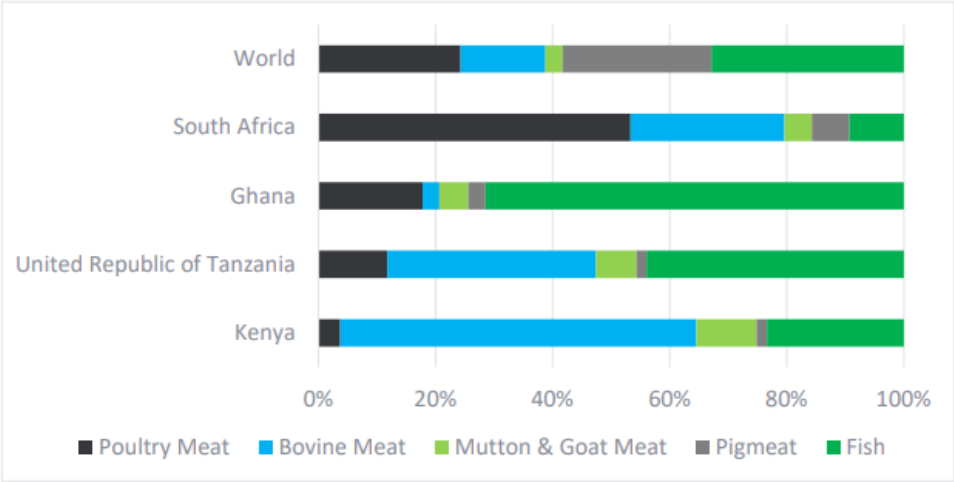

Figure 2.6 Composition of animal protein consumption in the region as compared to the world

Source: (Bureau for Food and Agricultural Policy, 2021)

Figure 2.6 shows that, in the region, chicken is not necessarily the preferred source of animal protein. Chicken is the second most popular source of animal protein in Ghana, right after fish. In Tanzania, chicken is the third most popular food after beef and fish. However, in Kenya, beef, fish, and ovine (sheep and goat) meat are preferred. This stands in stark contrast to South Africa, where chicken makes up more than half of the country's consumption of animal protein, and to the global average, where chicken, along with pork and fish, is one of the main sources of animal protein (Bureau for Food and Agricultural Policy, 2021).

In summary, the broiler industry is one of the fastest-growing food industries globally, and this is due to the growing global population, increase in purchasing power per capita, urbanisation and the increasing demand ignited by other down stream sectors(Mottet & Tempio, 2017).

2.3 South Africa Broiler Industry Overview

Within South African agriculture, the poultry sector is a significant subsector. Through its extensive, integrated value chain, it is the sole contributor to the overall gross agricultural production value and has a substantial upstream and downstream multiplier effect. Additionally, it offers South African consumers the most affordable source of animal protein, which makes it crucial for food security(Bureau for Food and Agricultural Policy and National Agricultural Marketing Council, 2019). About 90% of all poultry meat is produced as broiler meat, with the other 10% coming from adult bird slaughter (culls), small-scale and backyard broiler meat production, and other speciality broiler meat products (geese, turkey, ducks and guinea fowl). Broiler, hatchery, and raising industries employed 15 533 people in 2019, compared to 29 565 in the processing industry and 6 514 in the distribution of broilers. Fifty-one thousand and six hundred and twelve (51 612) people are employed across the board in the broiler sector. There are 18 817 people employed in field crops produced exclusively for chicken feeds. With 80% of the region's total broiler production, South Africa continues to be the region's top producer of poultry. The agricultural industry is dominated by broiler production, which continues to provide the cheapest protein in comparison to other animal proteins, followed by beef (Department of Agriculture Land Reform and Rural Development, 2020).

In the South African poultry business, about 75% of the birds are utilised to produce meat, and the remaining 25% are used in the production of eggs. Between 2004 and 2008, the South African broiler sector had significant expansion with an average annual growth rate of more than 7%. The industry's growth from 2009 to 2014 was only 1% yearly, a sharp slowdown. The industry expanded by 4.7% in 2015 (based on tonnes of meat produced, including spent birds and non-commercial production). The industry then experienced a 3.0 percent decline in 2015 and an additional 0.9 percent decline in 2016. The growth rate in the ten years from 2009 to 2019 was almost 1.7 percent yearly on average. To put these figures into context, the population grew by 1.4% annually between 2004 and 2008 and by 1.64 percent between 2009 and 2019 (South African Poultry Association 2019).

2.3.1 Gross Value of Slaughtered Broilers

According to the Department of Agriculture Forestry and Fisheries (2019), the contribution of animal products to the total gross value was 49.2%, followed by horticultural products at 30.3% and field crops at 20.5%. A large portion of the animal product contribution comes from the broiler industry at 16.8%, followed by slaughtered large stock at 12.5% and lastly, maize at 7.4%.

The gross value of broiler meat production from 2009–10 to 2018–19 is depicted in Figure 2.7 . The pattern indicates that gross value has been rising throughout the investigation. Only in 2018/19 did the value somewhat decline from the prior year. Over ten years, the average gross value of production was close to R35 billion annually. The rise in broiler meat production and pricing was the cause of the gross value increase.

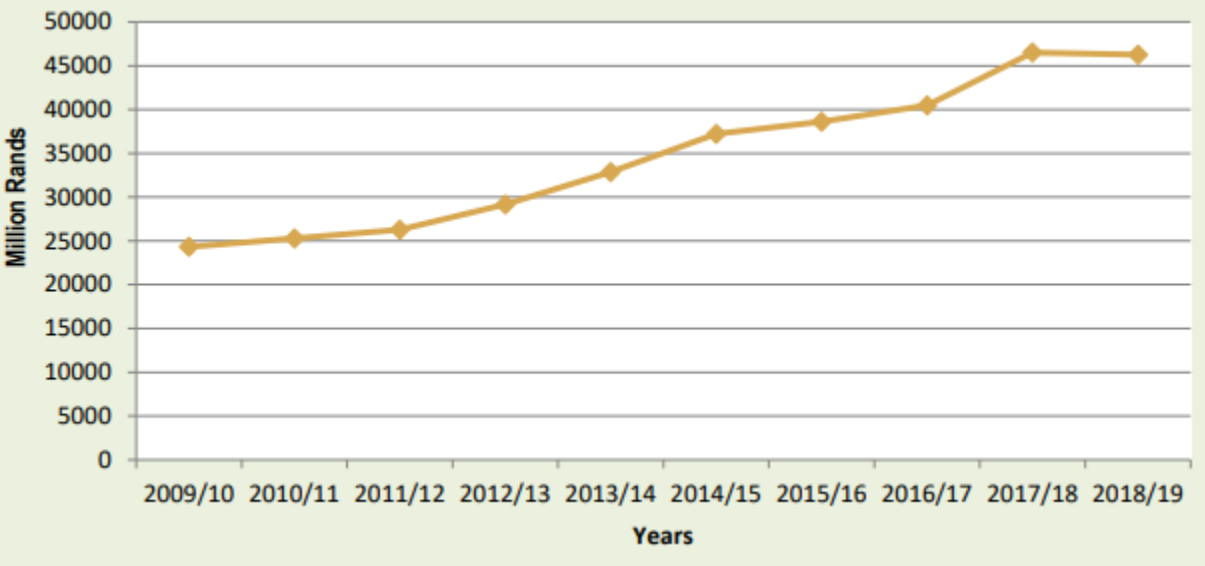

Figure 2.7 Gross value of broilers slaughtered

Source: (Department of Agriculture Land Reform and Rural Development, 2020)

2.4 Meat per capita Consumption in South Africa

In South Africa, broiler meat dominates the livestock industry in terms of production and is the main source of animal protein. Complex factors influence meat consumption. Broiler meat, the most economical meat choice, accounts for 60% of meat consumption, outpacing the worldwide trend, and over 75% of it is produced by seven commercial manufacturers (South African Poultry Association 2019). In the context of South Africa, commercial farmers are understood to be large-

scale, business-oriented producers on privately held farms, utilising intensive production systems with substantial investment and inputs, and who are extremely active in the formal market. Several important factors influence both the amount and type of meat consumed, including demographics, urbanisation, earnings, costs, tradition, religious convictions, cultural norms, and environmental, ethical/animal welfare, and health considerations (Food and Agriculture Organisation, 2021). Broiler meat consumption can be divided into two categories: non-brined and brined. Meat can also be divided into fresh, frozen, and IQF categories (Joubert, 2017). Consumer preferences differ between South Africa and developed countries. In developed countries, white meat (breasts) commands a premium price, whereas, in South Africa, consumers prefer brown meat (bone-in portions which include drumsticks, thighs, necks, and wings). Due to premiums given for white pieces, producers in industrialised countries make the most money from the carcass, while other portions are shipped at relatively low prices (Molepo, 2020).

The trends in South Africa's per capita consumption of various types of meat from 2005 to 2019 are depicted in Figure 2.8 . In comparison to mutton, hog, and beef, broiler meat has consistently had the highest per capita consumption from 2005–06 to 2019–20, as illustrated in Figure 7 . The per capita consumption of broiler meat in 2019–20 was 39.3 kilogramme, compared to 18.1 kg for beef, 5.2 kg for hog, and 3.1 kg for mutton. This reflects the fact that in South Africa, broiler meat is the most reasonably priced form of animal protein per kilogramme (Landbank, 2022).

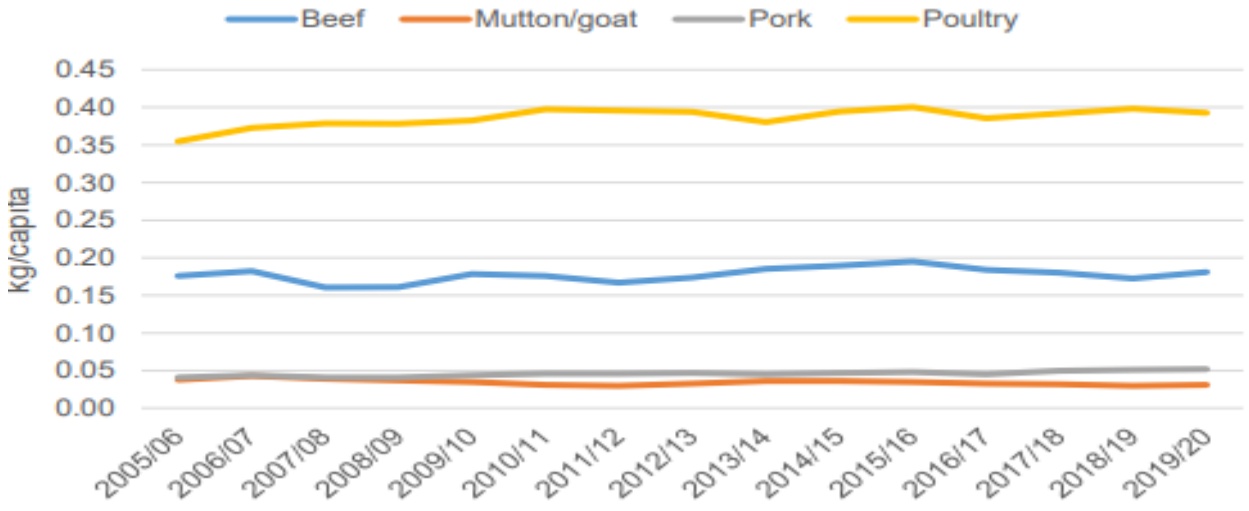

Figure 2.8 Per Capita (kg) consumption of meat 2005/06 to 2019/20

Source: (Landbank, 2022)

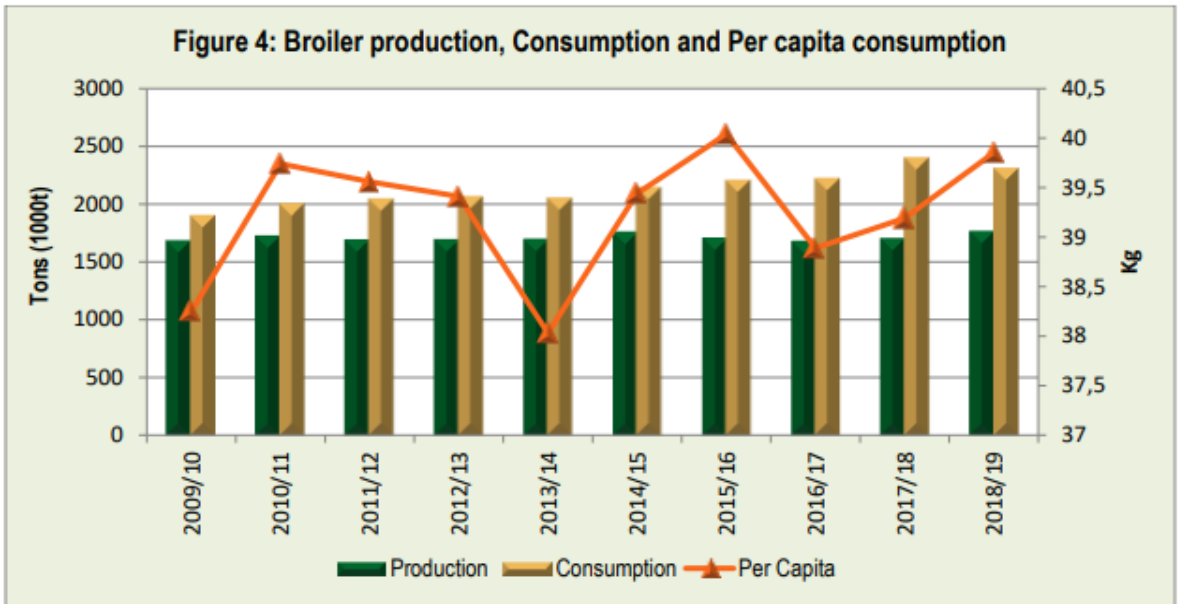

Figure 2.9 Broiler production, Consumption and Per capita consumption

Source: (Department of Agriculture Land Reform and Rural Development, 2020)

According to Figure 2.9 South Africa eats more broiler meat than is produced locally, indicating that it is unable to meet its needs and must rely on imports. While it consumed 2.3 million tonnes of broiler during the same period, South Africa produced a total of 1.76 million tonnes during that time. Because of the widening disparity between supply and consumption, South Africa became the world's largest net importer of broiler meat throughout the studied period. In South Africa, the amount of broiler meat consumed per person went from 39.19 kg in 2017/18 to 39.85 kg in 2018/19, an increase of almost 1.7 percent. This could be due to the rising cost of beef, which prompted customers to choose chicken as a more affordable meat option and for health reasons. Among all types of meat, broiler meat is consumed most frequently per person. This is the case because chicken is still South Africa's most economical source of animal protein (Department of Agriculture Land Reform and Rural Development, 2020).

2.5 Distribution of Broiler production in South Africa

The production of broilers characterises the entire South Africa and the largest producers accounting for 74% are Free State, Northern Cape, North West, Mpumalanga and Western Cape. The distribution of broilers in the country as of 2018 is expressed on the pie chart below (Department of Agriculture Forestry and Fisheries, 2019).

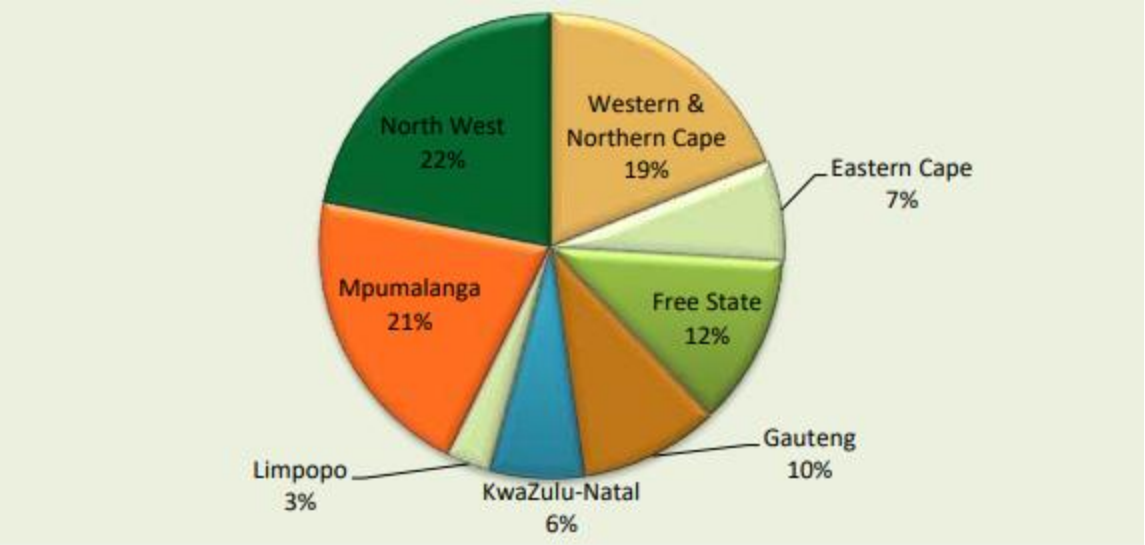

Figure 2.10 Distribution of Broiler in South Africa during 2018.

Source:(Department of Agriculture Forestry and Fisheries, 2019)

2.6 Broiler Value Chain in South Africa

The broiler industry in South Africa is not just a complicated supply chain, but it also has a high level of coordination and integration (Louw *et al.*, 2011). To produce efficiently, significant investment is necessary for highly particular assets, and as a result, the market is extremely consolidated, with a few large corporations controlling production (competitive). Broiler production is dominated by a limited number of vertically integrated enterprises, which provide all domestic supply to mainstream, official channels (Ncube, 2018). High levels of supply chain integration and demands for large production scales are the two main traits that are present in broiler value chains. As a result, a small number of substantial integrated companies that control a sizeable portion of the supply chain dominate the South African broiler business. Birds are raised by broiler producers under contracts with these businesses based on relational contracting (Davids, 2013). Because a broiler producer needs a lot of birds to be sold at once, contract growing is a common practice in the production of broilers worldwide. A contractual off-take agreement offers market assurance, which lowers exposure risk. This has led to the scale requirement for broiler production, at least in South Africa.

Numerous medium-small to very tiny producers who primarily sell live chickens or broiler products in the black market co-exist with integrated enterprises. Retailers of fast food and

supermarkets are also significant actors in the sector and heavily influence production standards (DAFF, 2017; Heijden & Vink, 2013; Ncube, 2018).

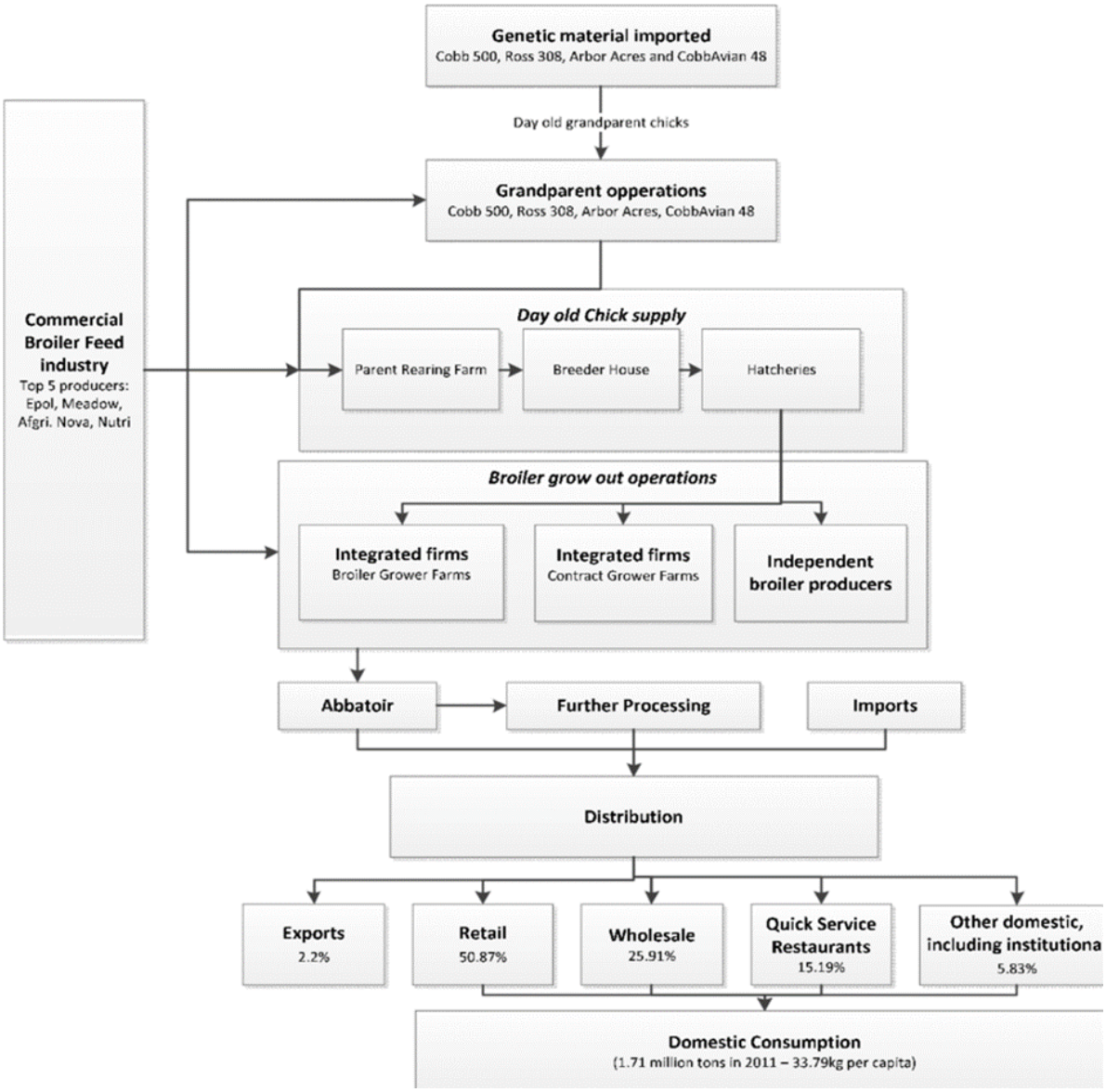

Figure 2.11 Diagrammatic representation of generic broiler supply chain in South Africa

Source: (South African Poultry Association, 2011b)

The first key step in the broiler chain system is the importation of broiler breeders. These broiler breeders are imported into the country at great grandparent or grandparent. They are imported as day-old chicks which are raised on breeder farms. Parent breeders supply day-old chicks to pullet farms before being moved to breeder farms to start production which lasts for 40 weeks.

Commercial broiler supply chain value in South Africa processors consists of subsidiaries or divisions within holding companies. Matured broilers can be supplied to independent growers who are contracted to holding companies or directly to company structures. Slaughtering of broilers and other processing activities can be handled by companies, and distribution and marketing of broilers can be done through retailers, restaurants, wholesalers, and other institutions.

2.7 Broiler imports in South Africa

Figure 2.12 shows that between 2010 and 2019, South Africa became a net importer of more broiler meat as imports considerably outpaced exports. This is an annual occurrence, and the problem may have been exaggerated by the suspected dumping of some chicken products on the South African poultry import market by the United States, Brazil, and the European Union(Department of Agriculture Land Reform and Rural Development, 2020).

According to De Beer (2010), the majority of imports are in the form of dark meat, which is a result of customer preferences in the United States, Europe, and South Africa. Consumers in the United States and Europe favour white flesh chicken breasts, whilst consumers in South Africa prefer leg quarters (dark meat). Hence there is a glut of leg quarters on the international market; they can be bought at low costs, lowering domestic prices and leading to dumping accusations.

Figure 2.12 Broiler imports and exports

Source : (Department of Agriculture Land Reform and Rural Development, 2020)

According to Figure 2.13 frozen chunks with the HS Code 2071490 were the most imported product. Frozen items accounted for 42.67 percent of total imports. Mechanically deboned beef (MDM – HS Code 2071210) was the second most common type of import. MDM accounted for 39.92 percent of total imports. The remaining imports are frozen carcasses not cut in parts (5%), offal (9%), frozen boneless cuts (3%), and frozen carcasses not chopped in pieces (other) (1 percent). Fresh or chilled entire chicken goods are not imported into South Africa.

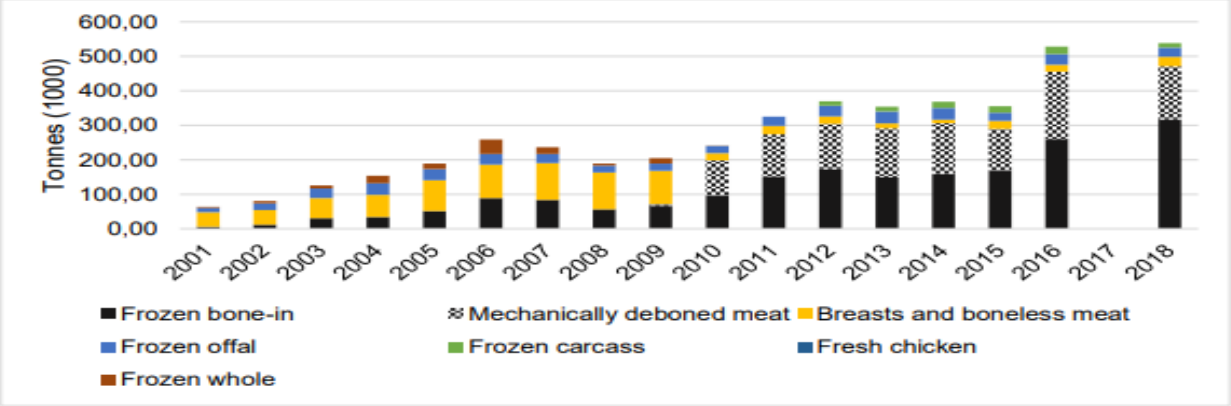

Figure 2.13Chicken portions

Source: (Astral, 2015)

Landbank (2022), indicates that broiler production in South Africa is insufficient to meet domestic demand. This is depicted in Figure 2.14 . Therefore, imports make up the difference in domestic consumption. According to the (National Agricultural Marketing Council, 2019), the difficulties the South African broiler industry faces limit its ability to compete and expand. Rising feed prices, disease outbreaks, import penetration, rising electricity prices, access to a dependable supply, currency rate volatility, and a lack of access to markets and funding are some of these difficulties.

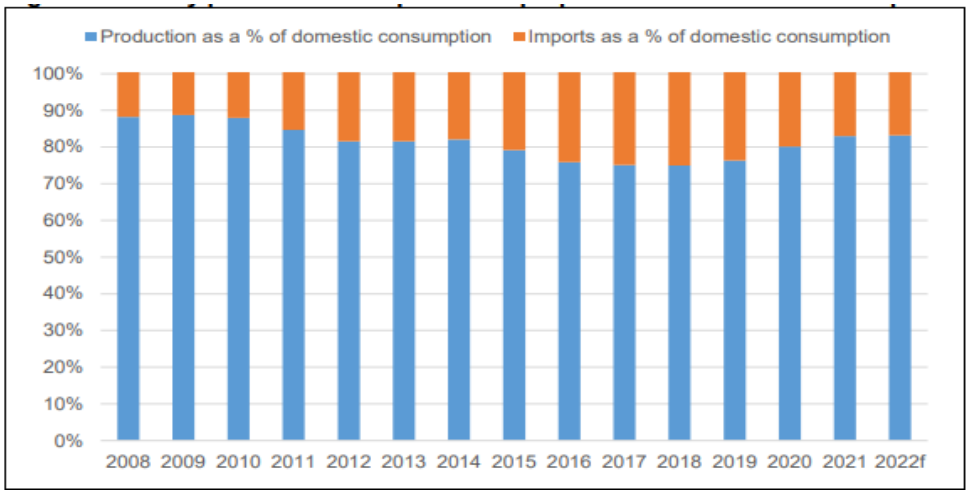

Figure 2.14 Poultry production and imports as a proportion of domestic production

Source: (Landbank, 2022)

According to the United States International Trade Commission (2012), as depicted in Figure 2.15, the cost of producing a live bird per kilogramme in Brazil ranged from 1.05 to 1.19 US dollars, depending on the region of production, while in the USA, the cost was roughly 1.01 US dollars. South African Poultry Association also indicates that the production cost per kg of live poultry in South Africa ranges from 1.28 to 1.38 US dollars. South Africa's production costs are unquestionably greater than those of the USA and Brazil.

According to Davids *et al.* (2015), the price of soybean cake, however, is a more fundamental variable underpinning the overall feed prices that affect the competitiveness of South African broiler producers. About 18% of the weight of the broiler feed ration is made up of soybean cake. South Africa is a net importer of soybean cake, whereas the US and Brazil are both net exporters of the product. This is because the local crushing industry has only just begun to expand its capacity to produce more soybean cake domestically. This suggests that the South African soybean cake price trades at import parity levels, as opposed to the export parity levels attained by the soybean cake price in Brazil and the US.

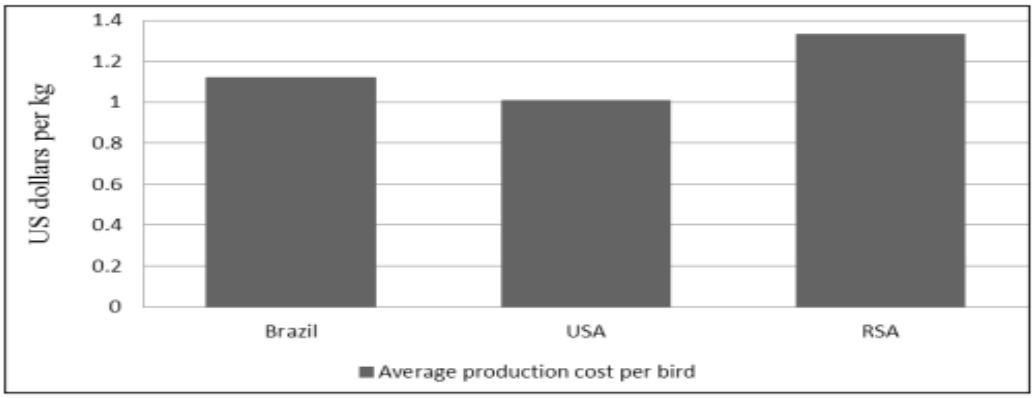

Figure 2.15 Average production cost /kg in Brazil, USA and South Africa

Source: (South African Poultry Association, 2011a; United States International Trade Commission, 2012)

2.8 Broiler exports from South Africa

The primary international markets for South African broiler meat exports in 2019 are depicted in Figure 2.16 . Lesotho received 46% of the broiler meat sent from South Africa, followed by Mozambique at 28%, Namibia, and Botswana at 10% and 4% respectively. The share of South African broiler meat exports to other nations in 2018 was 3% or less. It should be emphasised that the majority of South Africa's broiler meat exports, 63%, are to SADC nations.

The obstacles that SADC member nations must overcome range from circumstances of oversupply to a scarce or unpredictable food supply. The ability of the region to produce enough food to meet its needs is impacted by a variety of factors, including weather and climate, labour-intensive or outdated agricultural practices, and health problems that have an impact on agricultural productivity(South African Poultry Association, 2020).

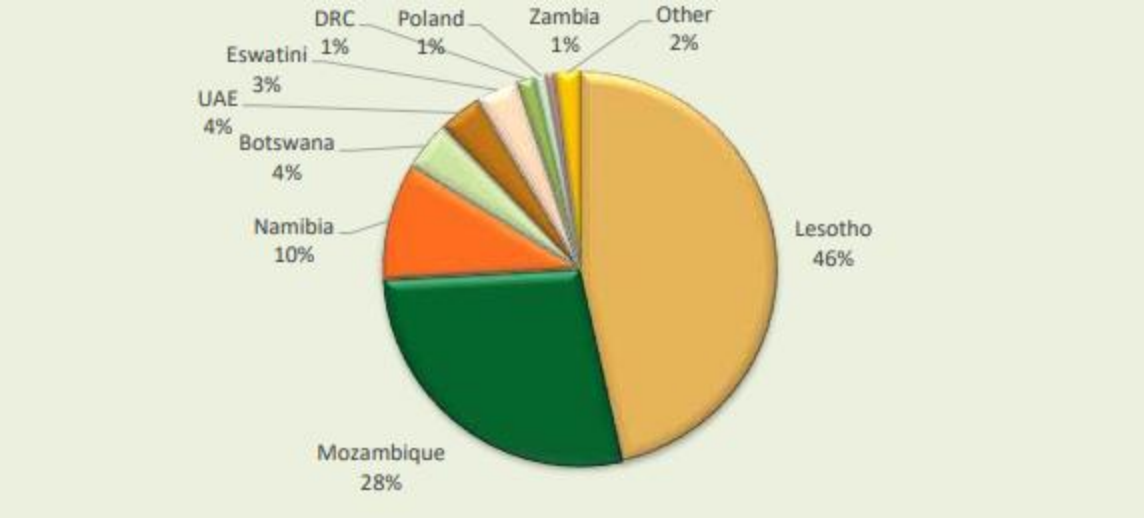

Figure 2.16 Broiler exports destination

Source : (Department of Agriculture Land Reform and Rural Development, 2020)

The continent of Africa is significantly reliant on imports from other parts of the world to help feed its expanding population. The majority of animal proteins utilised in the production of other products in Africa are imported as finished goods or as intermediary goods. Africa brought in over 14% of the world's poultry in 2013 (United States Department of Agriculture, 2013). As a result of rising income levels and urbanisation in the SADC region, it is anticipated that meat consumption would rise shortly, especially with regards to poultry (Ncube, 2018; Ncube *et al.*, 2016; Organisation for Economic Cooperation & Development OECD and Food and Agriculture Organisation, 2021).

Since the middle of the 2000s, regional trade, particularly that between South Africa and the other SADC nations, has increased quickly and has now reached levels that suggest significant macroeconomic relevance. Developments in the chicken business, one of the main areas within agro-processing, provide an example of how regional trade and food production capabilities have changed through time. (Arndt & Roberts, 2018). Although regional poultry production has expanded significantly, nearly all of the nations in Southern Africa are still net importers (Ncube, 2018).

Table 2.1 Broiler production in SADC

	Production		% Growth	% Total production		Population
SADC Country	2009	2019	(10 yr)	2009	2019	2019
Unit	Tonnes	Tonnes	%			M
Angola	15 660	49 034	+ 213	0.9	2.1	31.83
Botswana	5 836	2 403	- 58.8	0.3	0.1	2.30
Dem. Republic Congo	10 760	10 406	- 3.3	0.6	0.4	86.79
eSwatini (Swaziland)	5 200	6 229	+ 19.8	0.3	0.3	1.15
Lesotho	1 920	1 764	- 8.1	0.1	<0.1	2.13
Madagascar	37 520	50 037	+ 33.4	2.1	2.1	26.97
Malawi	21 337	135 725	+ 536	1.2	5.7	18.63
Mauritius	44 200	51 000	+ 15.4	2.5	2.1	1.27
Mozambique	39 796	76 080	+ 91.2	2.6	2.2	30.37
Namibia	11 200	10 866	- 3.0	0.6	0.5	2.50
Seychelles	607	560	- 7.7	<0.1	<0.1	<0.10
South Africa	1 387 599	1 808 207	+ 30.3	78.8	75.8	58.56
United Rep. of Tanzania	78 168	79 332	+ 1.5	4.4	3.3	58.01
Zambia	40 000	50 712	+ 26.9	2.3	2.1	17.86
Zimbabwe	61 870	52 115	- 15.8	3.5	2.2	14.65
Total for SADC	**1 761 673**	**2 384 530**				**353.0**

Source: (South African Poultry Association, 2020)

Based on Table 2.1 in the ten years leading up to 2019, broiler production levels increased significantly in Angola, Malawi, and Mozambique, and it increased somewhat in Madagascar, Mauritius, South Africa, eSwatini (Swaziland), and Zambia. Except South Africa, this development was, however, the result of a very low starting point and low per capita consumption. Therefore, there is still plenty of room to increase regional broiler meat production and per capita consumption (South African Poultry Association, 2020).

The 2019 table shows that as the region's neighbours build their economies, South Africa has been losing market share. Nevertheless, South Africa continued to dominate the SADC bloc's regional output of chicken meat in 2019, accounting for 75.8% of the total production (FAOstats). The following top producers were Malawi, Tanzania, and Mozambique, however, each produced less than 6% of the region's total broiler meat. Over the ten years from 2009 to 2019, the industry shrank in Botswana, the Democratic Republic of the Congo, Lesotho, Namibia, Seychelles, and Zimbabwe (South African Poultry Association, 2020).

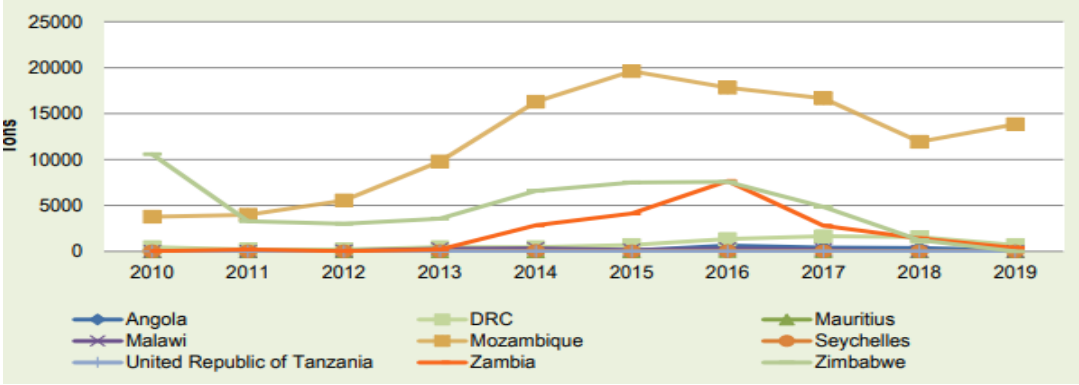

Figure 2.17 Broiler meat export to SADC

Source: (Department of Agriculture Land Reform and Rural Development, 2020)

Based on Figure 2.17 the majority of SADC nations which are known to be the key markets for South African exports, halted chicken imports from South Africa after the HPAI epidemic in 2017. Between 2017 and 2019, SADC's overall drop was 43%. According to Figure 2.17, Mozambique and Zimbabwe have been vying for supremacy among SADC nations for the past ten years. From 2011 to 2019, Mozambique was the top destination for South African broiler meat exports, whereas Zimbabwe was the top destination in 2010. Mozambique has significantly increased the amount of broiler it imports, reaching a peak of about 20,000 tons in 2015. From 2015 to 2018, fewer meat exports from South Africa went to Mozambique. With a share of more than 50%, the nation continued to dominate the SADC market. Most SADC nations had a fall in broiler meat exports in 2019, whereas Mozambique saw an increase and took a share of 92 percent.

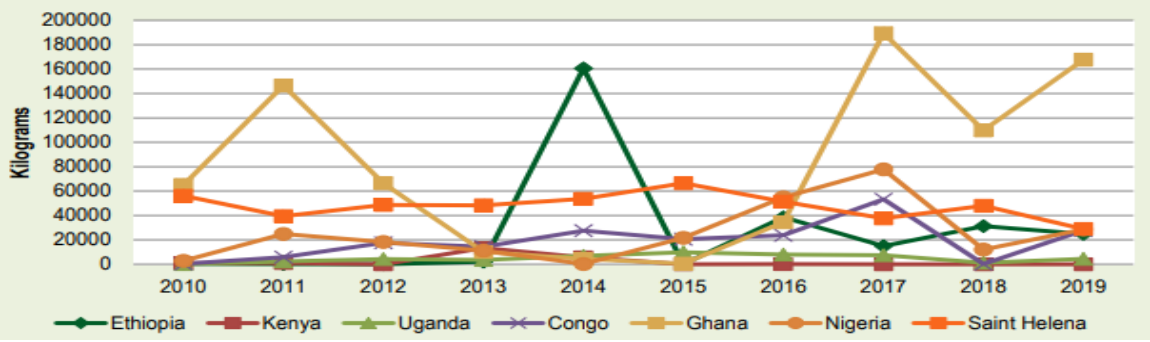

Figure 2.18 Broiler export to Middle, Eastern, and Western Africa

Source: (Department of Agriculture Land Reform and Rural Development, 2020)

Figure 2. 18 makes it evident that exports of broiler meat to the Middle East and Western Africa have fluctuated over the previous ten years. The country with the highest broiler meat exports

between 2010 and 2012 and 2017 and 2019 was Ghana. In 2012, 2014, and 2018, Saint Helena had the second-largest broiler meat export shares from South Africa, while it had the highest shares in 2013 and 2015. Over the past ten years, Ethiopia has imported less South African broiler meat; yet, in 2014, Ethiopia accounted for 62 percent of imports. The shipments of broiler meat to the Middle East, Eastern Europe, and Western Asia have risen from 2018 to 2019 by 39%. However, Ghana's gain of 135% makes this overstated.

2.9 Broiler Market Share in South Africa

Table 2.2 Broiler market share in South Africa

Companies	**Broiler Market share**
Astral + Tydstroom	29%
Rainbow	25%
CBH	8%
Chubby Chicks	6%
Day Break poultry (Afgri Poultry)	5%
Sovereign	5%
Grain Field Chicken	4%
Others	22%

Source (Joubert, 2017)

According to Table 2.2 over 50% of South Africa's broiler production is generated by Rainbow and Astral, while 24% of the nation's broiler meat was produced by five medium-sized processors, and the remaining 46% by smaller processors (Joubert, 2017). Rainbow Chicken, Astral and CBH are dominating the broiler industry, and the reason behind this is that they are the only holders of exclusive commercial genetic breeding licenses in South Africa, although two sizeable multinationals, Aviagen Broiler Breeders and Cobb-Vantress Inc., control the global market for genetic breeds. Therefore, whether for their production or commercial sales, any producer wishing to take part in the South African chicken value chain would have to buy breeding stock from Rainbow Chicken, Astral, and CBH (Ncube & Zengeni, 2016).

In 2014, there were 1.7 million tonnes of broiler meat produced, up from 928 000 tonnes in 2004. This shows a compound annual growth rate between 2004 and 2014 of 6.3%. The larger broiler producers, Rainbow Chicken, Astral and CBH are responsible for this growth (Ncube & Zengeni, 2016).

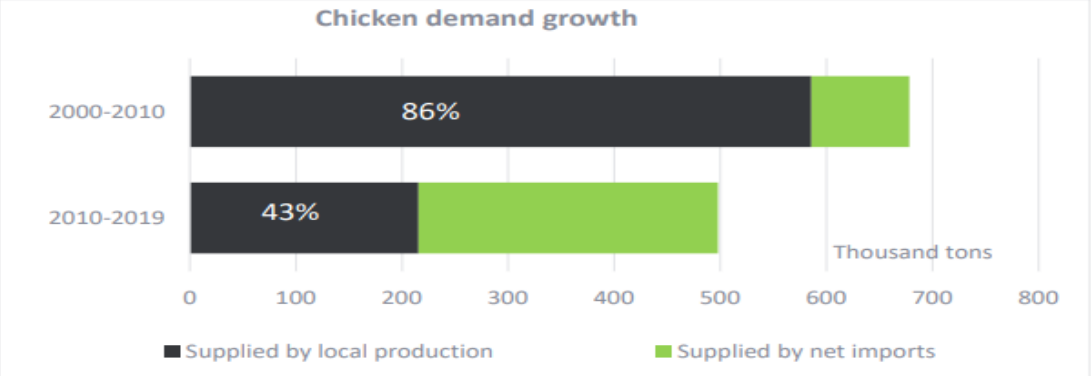

Figure 2.19 Chicken demand growth in South Africa

Source: (Bureau for Food and Agricultural Policy, 2021).

Figure 2.19 shows a 678 023 tonnes increase in chicken consumption in South Africa between 2000 and 2019. Eighty-six (86) percent of this gain was provided by an increase in domestic production. In contrast, just 43% of the additional 497 670 tonnes of poultry consumed between 2010 and 2019 came from domestic producers; the rest was imported. The ability of the sector to compete with top global producers was seriously questioned as a result of this trend (Bureau for Food and Agricultural Policy, 2021).

2.10 Factors affecting Supply Response

2.10.1 Imports and Tariffs

Agricultural trade protection has been extensively examined and debated around the world. Protectionism is still commonly practised worldwide, notably in agriculture, despite various arguments detailing the benefits of free trade. The major justifications for using trade protection have been to defend strategic industries, dissuade unfair competition, save jobs, and maintain a level of self-sufficiency (Laroche Dupraz & Postolle, 2011; Salvatore, 2016). According to to Gilani (2015), the import of agricultural products is dependent on the inflation rate; therefore, if

there is a difference in the inflation rates of the two nations, the nation with the lower inflation rate will experience an increase in domestic demand for its products, which may result in product imports that increase agricultural productivity. Because interest rates, which have an impact on currency rates, are directly tied to inflation, if the currency becomes strong, imports will be encouraged. Economic growth and imports are strongly connected, with causality extending both ways. Indeed, bigger imports follow quicker economic growth, but open nations tend to expand quicker than closed or inaccessible nations in terms of both imports and exports (Humpage, 2000). The gross domestic product of a nation is a crucial factor in determining economic growth. Any variation in the GDP has an impact on the nation's economic development; if the GDP rises, the nation's growth is improving, but if it falls, the nation's growth rate is decreasing rather than rising (Aslam *et al.*, 2018).

The government has many policy options when thinking about how to help a crucial industry like the broiler industry in South Africa (Davids *et al.*, 2015). These possibilities include deficiency payments, price assistance, quotas, and tariffs. Import tariffs have long served as significant defences against foreign competition. An import tariff effectively taxes imported goods, which has the additional benefit of significantly increasing government revenue (Houck, 1987).

A tariff's impact on both producers and consumers must be taken into account to demonstrate how it affects social welfare. This is depicted in the figure 2. 20 .

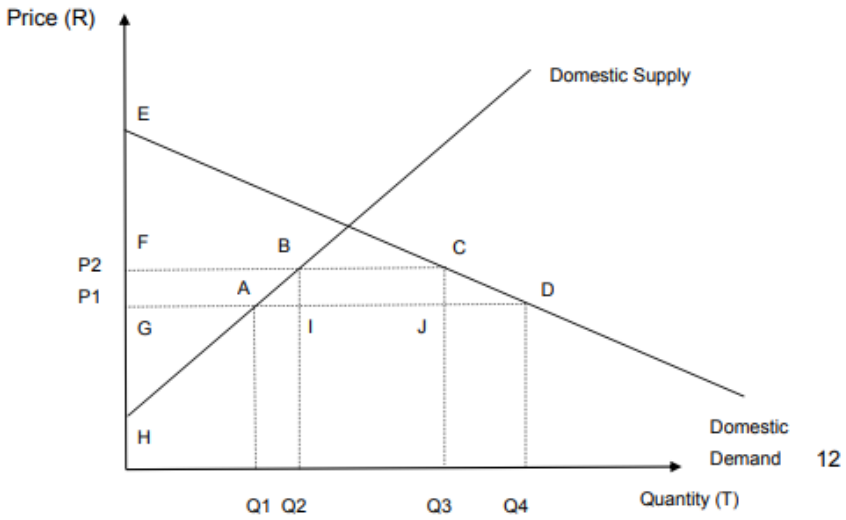

Figure 2.20 Effects of tariff increase on South Africa broiler imports

Source: (Salvatore, 2007)

Domestic consumption is Q4 at a price of P1, of which Q1 is produced domestically and the remainder is imported. Triangles GAH and EGD can be used to represent producer and consumer surplus, respectively. If tariffs rose, the price would rise to P2, domestic consumption would fall to Q3, with Q2 being produced domestically and the difference between Q3 and Q2 being imported, and domestic production would climb to P2. Triangle HFB can now be used to represent producer surplus, increasing area FBAG's producer surplus. Consumer surplus is now represented by the triangle EFC, which is a reduction of the area FCDG. Society would suffer a net loss in area ABCD. Triangles ABJ and ACD will experience a net loss to society as a result of the tariff, whereas the area represented by rectangle IBCJ will benefit from the tariff in the form of increased government revenue.

A drop in imports was partially caused by an increase in tariffs. Although this is wonderful news for regional farmers, it is crucial to consider how it will affect household affordability, or the retail costs for poultry goods (Farmer'sweekly, 2021). To obtain a balanced result between the need for support for producers and the impact of that support on consumers, alternative measures or policy interventions may also be taken into account. According to Davids *et al.* (2015), tariff that is triggered by a certain ratio of foreign prices to domestic feed prices could be taken into consideration. The chicken-to-feed price ratio continues to be a key indicator of the industry's global competitiveness. This would lessen the impact on consumers while occasionally helping producers. A zero VAT rate on chicken might potentially result in a more balanced outcome because producer prices could rise without increasing the retail price, but it is important to take into account the ripple effects on other meat businesses and the decline in tax revenue.

The South African Department of Trade and Industry (DTI) classified the broiler industry as being in distress (Davids *et al.*, 2015). According to the South African Poultry Association (SAPA), the main causes of this distress are rising feed costs and an oversupply brought on by an influx of relatively cheaper imports. As a result, a review of the current tariff structure has been started by the International Trade Administration Commission of South Africa (ITAC).

Agriculture trade protection has been the topic of in-depth study and debate on a global scale. Despite numerous arguments in favour of free trade, protectionism is still common in many nations, particularly in agriculture. The main grounds for implementing trade protection have been to protect significant industries, stop unfair competition, preserve jobs, and maintain a certain level of self-sufficiency (Laroche Dupraz & Postolle, 2011; Salvatore, 2007).

The broiler sector contributes to agricultural production and food security, although growth has recently been challenged. An ever-increasing influx of imports of chicken at low prices combined with rising feed costs led to limited price increases, squeezed margins, and restricted future investment. Since 2010, imported goods have provided more than half of the increase in chicken consumption. Imports rose by more than 90% from 240 000 to 457 000 tonnes between 2010 and 2015, raising questions about the industry's ability to compete globally and, as a result, its long-term sustainability (Davids & Meyer, 2016).

South Africa as the net importer of broiler products is affected by variations in the global markets, and these changes influence the industry to gain insight into the performance of the South African market within the circumstances of the foreign markets (De Beer, 2010). The increase in imports from the EU is mostly due to the free trade agreement with the EU. In 2010, South Africa imported 12 800 tonnes of poultry meat, up 1363 percent to 188 041 tonnes in 2014. These imports are in addition to Brazilian imports (Joubert, 2017). In addition, South Africa had been a beneficiary of AGOA since 2000, but there was a strong view in the US Congress that it was too large and developed an economy to continue receiving unilateral preferential treatment from the US, and that it should be graduated out of AGOA by the end of September 2015. Under the AGOA agreement, US poultry producers have nearly met their 65 000-tonne export quota for the 2016/17 season. Between 2009 and 2019, broiler imports, mostly from the Americas and the EU, rose by 160 percent, and by 88 percent between 2010 and 2020. While local producers complain that imports are driving small producers out of business, eliminating investment, and preventing bigger enterprises from using their full production potential, importers contend that imports are filling a demand that local producers just cannot supply.

Table 2.3 Classification and tariffs of broiler imports to South Africa

Classification Code	Description	Tariff
02071100	Fowls, not cut in pieces: fresh or chilled	0%
02071210	Fowls, not cut in pieces, frozen: mechanically deboned meat	0%
02071220	Fowls, not cut in pieces, frozen: carcasses	27%
02071290	Fowls, not cut in pieces, frozen: other	27%
02071300	Fowls, cuts and offal, fresh or chilled	0%
02071410	Fowls, cuts and offal, frozen: boneless cuts	5%
02071420	Fowls, cuts and offal, frozen: offal	27%
02071490	Fowls, cuts and offal, frozen: other (includes bone-in portions)	220c/kg

Source: (International Trade Administration Commission, 2013)

2.10.2 Exports

Numerous theoretical and empirical studies have been conducted as a result of the growing popularity of openness to the outside world policy, or more specifically, the influence of global trade on the development process. There is a rather high positive link between export and real income growth throughout the Sub-Saharan African countries, although the direction of causality between economic growth and export revenues is still debatable (Svedberg, 1991). Exports of agricultural products are also influenced by the availability of inputs because these can be used to produce more goods or commodities that can be exported when there are more available, at a lower cost, and with more effective technology. In addition, other factors may have an impact on agricultural exports (Gilani, 2015). According to Fosu (1992), an economy's agricultural exports are indirectly impacted by the real exchange rate (RER) of its native currency; rather, agricultural exports are impacted by its effects on the incentive structure.

The inelasticity of agricultural export reaction to changes in the real exchange rate suggests that significant modifications may be required to drive increases in agricultural exports. Contrary to Amin's (1996) findings, this author concluded that it is impractical to promote increased agricultural exports just through changes to the RER (Amin, 1996). The responsiveness of the agricultural export supply is so significant; much empirical research has concentrated on this issue.

Almost all research that has looked at the factors influencing the export supply of agricultural commodities has concluded that exports from least-developed countries (LDCs) are more sensitive to pricing factors (Balassa, 1990; Gerrard *et al.*, 1994; Tshibaka, 1997). Therefore, price determinants are essential in encouraging agricultural exports.

Broiler exports from South Africa are headed for SADC countries. This market has a similar structure, with the majority of consumers preferring brown meat and non-tariff restrictions making doing business in SADC countries prohibitively expensive. For example, trucking is used for the majority of intra-SADC trade, and delayed border clearance is a major non-tariff obstacle (Molepo, 2020). According to Slater (2022), the whole broiler value chain, from local producers and their shareholders to medium-sized and small-scale farmers, exporters, processors, and consumers, may benefit significantly from a strong and prosperous poultry export market for South African chicken in the EU, but only chicken products devoid of antibiotics, hormones, brine, and feed containing animal byproducts will be imported by the EU. Brining is particularly difficult, according to the South African Association of Meat Importers and Exporters (AMIE), as it is illegal in the EU and also in the majority of South Africa's potential export partner markets. It also has a troubled past in South Africa, where local chicken may contain up to 15% brine, a limit enacted in 2016 in response to findings that domestic chicken parts could contain as much as 60% water. In March 2022, the EU was paying roughly €6/kg for the between 900 000 and one million tonnes of the chicken breast it imports annually. The upside for local farmers is significant since South African producers, who have an excess of chicken breasts, are selling them locally for a third of that price. South Africa has also been benefitting from the largest free trade area in the world, the African Continental Free Trade Area (AfCFTA) which rejects traditional, neo-traditional, and Marxist trade theories in favour of non-aligned Pan-Africanism; it promotes continental free trade (Obeng-Odoom, 2020). Under the terms of the African Continental Free Trade Area agreement, South Africa enjoys favourable, duty-free trade conditions (Slater, 2022). The expansion of the African Growth Opportunity Act (AGOA) by the United States in 2015 put even more pressure on the local industry. AGOA is an agreement between the United States and some African countries that meet specific US standards. AGOA allows these countries' export items to enter the US duty-free (Williams, 2015).

2.10.3 Feed

The cost of feed continues to be the key issue affecting the competitiveness of broiler producers because it is the single largest contribution to variable production costs (Bureau for Food and Agricultural Policy and National Agricultural Marketing Council, 2019). The cost of feed makes up between 60 and 70 percent of the entire cost of production, making it a key factor in the evolving production and marketing environment for poultry and chicken products. More farmers are eager to enter the industry with lower feed costs, and most of them would like to raise more birds. Since feed is the major expenditure in any method of poultry production, few developing nations have benefitted from the development of poultry (Reddy & Qudratullah, 1996). The feed industry, according to Louw *et al.* (2013), is facing several difficulties, and nutritionists are expected to offer affordable solutions without sacrificing effectiveness. Cost increases and the related issues with supply, price volatility, and link optimisation within integrated supply chains continue to present difficulties. According to Rezitis and Stavropoulos (2010), the price of feed has a greater impact on broiler production than the cost of veterinary care, showing that feed is the primary cost component. It has been revealed that the degree of price elasticity in the broiler supply is comparable to that found in other studies, but that the effects of price volatility and broiler feed costs are greater than those found in other studies. Furthermore, the study revealed that the price of broiler feed is the most important cost element in the supply response function, and price volatility is a substantial risk factor (Rezitis & Stavropoulos, 2010).

Maximum profit might be attained by acquiring the greatest margin over the variable cost. The margin can be raised in two different ways. Firstly, returns must be raised, either by increasing production or by raising the price at which the product is sold. Secondly, it is important to cut the variable cost as much as you can. (Waller, 2007) claims that feed costs make up most variable costs, amounting to up to 70% of the overall cost. The only method to reduce feed costs in the face of rising feed ingredient costs is to scale back the feed's nutrient requirements (Waller, 2007).

Variable inputs costs in South African broiler production cycle, stipulated in most contracts, are summarised as follows:

Table 2.4 Variable production cost breakdown of South African broiler producers

Variable cost component	**Average share of variable cost**
Feed	71.3%

Day old chicks	20.0%
Labour	1.3%
Heating and electricity	3.3%
Bedding, waste removal and cleaning	1.7%
Vitamin and vaccinations	0.6%
Maintenance	0.7%
Catching	0.4%
Others	0;7%

Source: (Davids & Meyer, 2017)

Feed is one of the most expensive components of broiler production in the world. According to Table 2.4 feed and day-old chicks account for 91 percent of variable expenditures on average, and the integrated company always supplies them. As a result, producers have little say in the quality or price of inputs, which account for over 90% of variable production expenses per cycle (Davids & Meyer, 2017). The most important variable input for broiler producers is feed supply. Louw *et al.* (2011), also estimates that feed costs account for 70% of broiler producers' inputs, making good quality feed at consistent pricing critical to successful broiler production.

According toAl-Deseit (2009), yellow maize or corn makes up 60 to 70 percent of feed, while soybean meal makes up 25 percent, with various components and nutrients making up the rest, depending on the feed ration. If the price of white maize in South Africa falls below the price of yellow maize, white maize is substituted for yellow maize in the manufacturing process.

The fluctuation of feed costs in the sector causes a lot of uncertainty, which is due to a few variables. The maize market in South Africa is quite unpredictable. Maize prices can fluctuate from import parity (drought) to export parity in a single season. Within a single production season, this swing can potentially exceed R1 000/tonne. A variable South African currency rate adds to the overall volatility of feed prices.

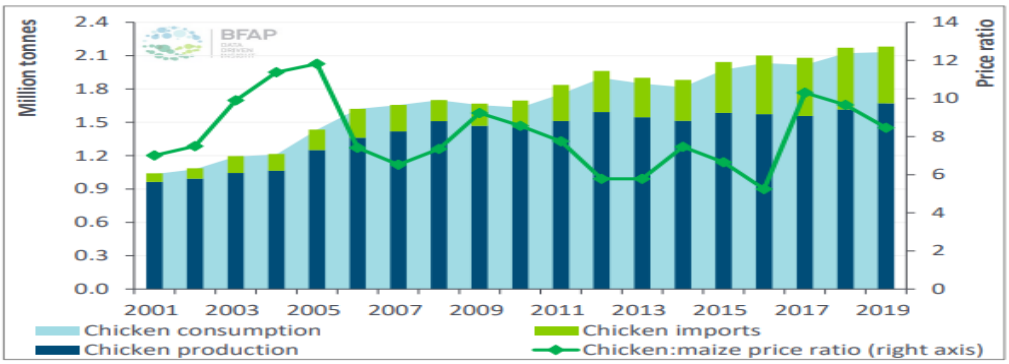

Figure 2.21Chicken consumption, production, imports & chicken maize price ratio in South Africa

Source : (Bureau for Food and Agricultural Policy, 2021)

Figure 2.21 indicates that the chicken-to-maize price ratio has largely maintained significantly below the levels seen from 2003 to 2005, despite some volatility. In addition to global dynamics, domestic weather has been particularly unpredictable in recent years, which has caused maize prices to swing between import parity and export parity levels. In 2016, when South Africa had the worst drought in a century, corn prices reached an all-time high, driving the chicken-to-maize price ratio to an all-time low (Bureau for Food and Agricultural Policy, 2016). Chicken price hikes were constrained by the fact that imported goods effectively served as a ceiling, and when the price of yellow maize rose by 25 percent annually in 2016, chicken prices grew by less than 1 percent (Bureau for Food and Agricultural Policy, 2021)

South Africa cannot meet its demand for soybeans or soybean meal and must import them. Local soybean production accounts for roughly 30 to 40% of total meal consumption, while production varies based on weather patterns (Joubert, 2017).

Increases in input costs, particularly feed, have been one of the key factors driving higher domestic broiler producer pricing (USDA, 1996; Vink and Kirsten, 2002). Exchange rate fluctuations have a significant impact on the prices of feed ration components.

2.10.3.1 Maize and Soya bean Production as Major Feed Ingredients for Broilers

Maize and soybeans are still the favoured energy and protein-producing ingredients in many parts of the world (Ravindran, 2013). Maize is a major consumer in the South African broiler sector, as it is the principal energy source in broiler diets. A direct linear relationship between chicken production and maize consumption is depicted by changes in the relative worldwide output of

crops and animals (Nkukwana, 2018). Maize production in 2019/2020 was estimated to be around 15.1 million metric tonnes. This indicates a 27.9% increase in maize production in the previous year. South Africa's exports fell by around 8.2 million metric tonnes in 2015/2016. The extreme drought that occurred between 2015 and 2017 was a major factor in this (Galal, 2021).

South Africa produces enough maize in normal years and is considered a net exporter. This keeps feed prices at export parity, resulting in decreased feed costs. South Africa must progress to the point where it is self-sufficient in the production of all feed ingredients, and so become a net exporter of maize and soybeans (Joubert, 2017). When it comes to broiler production, South Africa meets internal standards in terms of technical efficiency, but economic efficiency, which accounts for production costs, paints a different picture. The most significant driver of South African producers' lack of competitiveness is the expense of soya oilcake as the principal source of protein in broiler feed. As a net importer of Soya oilcake, the price is at import parity, whereas Soya oilcake prices in Brazil, the United States, and Argentina are at export parity (Davids & Meyer, 2017).

The cost of transportation is one of the major obstacles to regionalisation. The cost of delivering Zambian soybeans to South Africa has historically been so high that it makes Zambian imports of soybeans uncompetitive with imports from Argentina, even though the output of soybeans in Zambia has increased and the price of soybeans is competitive. However, the cost of transportation has decreased since 2017 (Goga & Bosiu, 2019). Even though there is significant potential for agricultural production of the primary inputs, the southern African region is a net importer of both poultry and one of its important commodities, oilcakes, is required for the creation of animal feed. The regional trade imbalance is primarily due to South Africa's trade deficits in chicken ($270 million, or around 15% of domestic demand) and oilcake ($257 million) in 2014. While South Africa produces an excess of maize due to agricultural conditions, it is limited in its ability to produce soy and feed-related goods like oilcake, which are primarily imported from South America (Ncube *et al.*, 2016).

2.10.4 Diseases

Highly Pathogenic Avian Influenza (HPAI) pandemics are uncommon yet frequent occurrences. A new epidemic in South Africa will notably have a negative impact on the ostrich and poultry

sectors. With the poultry industry already in trouble due to ongoing battles with cheap meat imports from the US and Europe and the ongoing higher-than-normal feed prices that are limiting South African producers' ability to compete on the international market, these industries can ill-afford another setback. Kevin Lovell of the South African Poultry Association (SAPA) believes that a second Avian Flu outbreak would not have a substantial long-term impact on the poultry business, primarily because the nation only exports only 3.7% of its whole poultry production. However, if the disease were to spread, it might still have a significant effect on the pricing and availability of poultry items in the local market (Pienaar, 2017). Economic growth would probably be slowed or stopped by a pandemic, and trade, particularly in services, will likely decline significantly. Potential economic growth will be slower in the long run, and poverty will rise (Bureau for Food and Agricultural Policy, 2018A).

According to Bloom *et al.* (2005), a pandemic is expected to have an impact on consumer confidence and alter social and consumption habits on the demand side. Additionally, it will impact investor confidence, which may have significant long-term repercussions. A pandemic will have an impact on the supply of labour since many workers will be forced to stay at home due to illness. The livestock industry will continue to suffer as a result. As they react to the public health emergency and the economic disruption, governments will have to deal with an unclear policy environment. Markets often overreact, which might make the effects on the economy worse. The disease also led to significant price increases, which tempted some producers to take the risk of expanding production but also led to much higher costs and decreased consumption levels. Despite the decline in production volumes, the nature of the product implies that trade has a very limited role in the domestic market (Bureau for Food and Agricultural Policy, 2018A).

The poultry business was significantly impacted by the recent South African outbreak of the highly virulent H5N8 virus in 2017 According to the South African Poultry Association (2020), the outbreaks of HPAI have disastrous consequences for both poultry and consumers in terms of a national protein supply, food security and food pricing. In the event of a catastrophic disease outbreak, the cost of restocking and disinfection programmes can run into billions of rands.

It should be highlighted that the impact of a disease like HPAI resulted in catastrophic losses in some places, similar to the majority of agricultural sectors, while producers who were not afflicted benefitted from increased pricing. Therefore, it is important to remember that afflicted

communities sustained significant losses before evaluating the overall national impact. To manage the disease, a culling plan must be used, and compensation for such losses is crucial.

During 2017 outbreak, a total of 712 377 chickens were culled from broiler breeders. The breeding flock was the subject of all instances involving broilers, with outbreaks occurring in Mpumalanga, Gauteng, the Western Cape, and the Eastern Cape. The projected number of broiler breeding birds in July 2017 was 6.6 million, as per the SAPA report. Therefore, the outbreak's overall impact was the loss of 10.8% of South Africa's domestic breeding flock. The loss is estimated to be worth R68.3 million (Bureau for Food and Agricultural Policy, 2018A).

The outbreak has been contained in South Africa by eradicating afflicted areas. A prospective vaccine strategy is being thought about, but it has not yet been formalised. A culling technique has often been used in the international setting, along with compensation for impacted producers, which emphasises the significance of calculating the disease's economic impact (Bureau for Food and Agricultural Policy, 2018A).

Table 2.5 Estimated income forgone due to the 2017 Avian Flu outbreak

	Value of income foregone (Rands)	Share in gross value of egg production in 2016 (%)	Share in gross value of broiler production in 2016 (%)
Income lost from commercial egg sales	408 million	4.00%	-
Income lost from layer breeder flock	813 million	7.99%	-
Income lost from day old pullets	37 million	0.36%	-
Income lost from point of lay hens	26 million	0.26%	-
Income lost from commercial egg sales	750 million	7.37%	-
Income lost from broiler breeder flock	287 million	-	0.74%
Income lost from DOC's	200 million	-	0.52%
Income lost from broiler meat sales	87 million	-	0.23%
Total income foregone	**1.508 billion**	**14.83%**	**3.91%**

Source: (Bureau for Food and Agricultural Policy, 2018A)

Table 2.5 explains the estimated income forgone during the outbreak of the Avian Flu in 2017. According to the Bureau for Food and Agricultural Policy (2018A), strong assumptions were used to calculate the loss of income for the broiler chain at the breeder level. For the sake of this computation, it is assumed that breeder populations have an average age of 40 weeks and that broiler parent birds are productive between the ages of 26 and 60 weeks. This suggests that an outbreak at the breeder level results in a 20-week average loss of productive time. Additional presumptions include a hatchability of 0.85 and a laying efficiency of 0.8 per day. Feed costs of

R3567 were used to calculate gross profits. Furthermore, it was estimated that birds eat about 115g of food each day. According to the aforementioned hypotheses, each culled bird "loses" 95-day-old chicks during 20 weeks. This corresponds to an estimated total loss of R200 million in income from day-old chicks given the number of culled broiler breeder birds. Due to lower sales of broiler meat, this will result in income loss of almost R87 million. The R287 million in total revenue lost as a result of the epidemic in the broiler breeder flock is 0.74% of the gross value of all broiler output in South Africa for 2016.

2.10.5 Exchange Rate

Exchange rate risk is one significant element that has impacted agricultural commerce (volatility). Exchange rates between trade nations sometimes fluctuate, which undoubtedly applies to African nations like Sao Tome & Principe, Somalia, Zimbabwe, and Guinea. Exchange rate volatility and producers' low-risk appetite might occasionally impede international trade. Numerous studies have demonstrated that exchange rate volatility has a detrimental effect on the trading of agricultural products (Davis *et al.*, 2014). It is commonly known that exchange rates have an impact on agricultural trade. According to the studies, exchange rate fluctuations have a considerable impact on trade flows, with the effects typically being sector- and/or commodity-specific (De Grauwe & Skudelny, 2000; Langley *et al.*, 2000; Shane *et al.*, 2008)

It is generally said, volatile exchange rates make international trade more dangerous, causing risk-averse producers to withdraw to the home market (Davis *et al.*, 2014). Domestic broiler prices are still heavily influenced by the Rand/US-Dollar exchange rate as well as international poultry pricing and will remain so as long as South Africa is a global participant (De Beer, 2010). (Davis *et al.*, 2014) analysed global broiler trade flows from 1999 to 2008 and discovered that, while exchange rate volatility had a negative influence on broiler trade over the long run, it had no effect over the short term. Numerous studies have demonstrated that exchange rate risk or volatility has detrimental effects on agricultural trade (Cho *et al.*, 2002; Kandilov, 2008; Karemera *et al.*, 2011; Pick, 1990). However, the impact of exchange rate volatility on trade for animal proteins, notably poultry commerce, has been mixed (Davis *et al.*, 2014; Bonroy *et al.*, 2007; Awokuse & Yuan, 2006; Jones, 2006).

2.10.6 Broiler Prices

A portion of the price of broilers is compatible with the quassi rational expectations, where future prices are predicted based on previously observed historical patterns. However, a large portion of the market is discovered to be connected to naive expectations, where future prices are projected based on the most recent price observed (Chavas, 1999). The empirical findings of Chavas' study on dynamic arbitrage pricing and information (the case of the US broiler business) showed that there were a variety of expectations, including both naive expectations and the quassi rational expectations. They also claim that most US broiler sector decision-makers have naive expectations (Chavas, 1999).

The price of the product is one major incentive to produce. According to economic theory, favourable pricing frequently influences producers' decisions to produce. As a result, prices have a significant impact on decisions about how much to produce in the agriculture sector.

Only in the price range when the price is more than or equal to the minimum of the average variable cost is the supply function defined. Therefore, a product's production and supply volume is influenced by its own price, the prices of substitute and complementary items, and the pricing of inputs (Muchapondwa, 2009).

The main finding from the firm theory is that price is the primary predictor of supply. Thus, supply can be written as the inverse of the marginal cost function and is growing in the market price. Ménard (1996), identified three different types of contracts when analysing contracts used in the French broiler industry. These include fixed-price contracts where the growers are self-sufficient and promise to deliver a specific quantity of chickens by a specific date. Contracts detail the features of the broiler to be provided as well as the amount to be paid. In South Africa, broiler contracts are structured similarly to international contracts, with the two primary components being the obligation for delivering inputs and the system for determining the grower’s compensation (Davids & Meyer, 2017). A two-part cardinal tournament plan is used to settle almost all contemporary broiler contracts. This scheme includes a fixed base payment per pound of live meat produced and a variable bonus payment based on the grower's relative performance (Zheng & Vukina, 2007). Feed and day-old chicks supply 91% of variable costs on average and are always provided by the integrated enterprise. Thus, producers have little control over the

quality or pricing of the inputs that make up more than 90% of a production cycle's variable expenses (Davids & Meyer, 2017).

With all phases from breeding flocks, hatcheries, and grow-out to feed mills, transportation divisions, and processing factories, the broiler sector offers a fully vertically integrated chain. Contracts with independent growers are used nearly exclusively to organise the production of live birds. Broiler companies (known as integrators) have complete control over the whole production process, from breeding flocks and hatcheries to broiler grow-out and processing. In broiler markets around the world, many types of contracts are employed, with important distinctions in the duty for delivering inputs and the assessment of the grower's remuneration (Vukina & Leegomonchai, 2006).

The same tournament pricing utilised successfully in the USA is applied to the South African broiler production contracts, resulting in high levels of technical efficiency but lacking in economic efficiency (Davids & Meyer, 2017). The producer and integrator stand to gain from the price formation mechanism as it is stated. It gives individual producers a strong incentive to boost their efficiency because doing so will increase their profit relative to the performance of the group. At the same time, as each person continues to develop, the group average also rises, lowering the integrator's costs (Davids & Meyer, 2017).

The domestic price of chicken is more sensitive to changes in the import parity price than to changes in feed prices, according to a univariate time series analysis (Davids & Meyer, 2017).
In the study conducted by van Wyk (2011), the price was the only production variable included for analysis and is based on the initial work done on agricultural commodities supply. The major justification for using price as the single production (independent) variable in supply response research is that higher output prices enhance profit, which in turn encourages producers to produce more of a particular commodity. In these studies, there are several variables that have been included in the model as independent, and base and the above statement byvan Wyk (2011), will be tested to check if the price is the only variable that influences the responsiveness of broiler producers in South Africa.
Traditionally, feed costs, animal market prices, interest rates, institutional variables, and lagged dependent variables have always been used to simulate the animal supply response in the past. Regardless of institutional and economic variables, unobservable factors such as technical

advancements, demographic characteristics, and other exogenous variables, have impact on animal supply responses. The effect of these unobservable variables has either been neglected or described by a simple linear deterministic time variable that assumes a fixed underlying trend effect overtime in the existing animal supply response literature (Kapombe & Colyer, 1998).

2.11 Theory of Production Economics

Economics involves making decisions. The producer aims to maximise utility as well. The producer is driven to maximise usefulness by a desire to profit, once more for improved fulfilment of limitless desires. The producer frequently tries to maximise profit as a way of gaining utility or satisfaction, even when the producer may have other purposes (Debertin, 2012). By definition, production economics is a branch of applied economics that deals with how to use resources such as capital, labour, land, and management in the agricultural sector. The connection between input use and output level is described by the production function. According to Penson *et al.* (2015), a production function is a rule that links a specific output to a set of input levels. The production function was also described by Wall and Fisher (1987) as a key methodology for examining production choices, the activity of production. The production function in its general form is;

$Y = (\boldsymbol{X_1}+\boldsymbol{X_2}+\boldsymbol{X_3} + \boldsymbol{X_4} + \boldsymbol{X_5} + \boldsymbol{X_n})$

Where Y is the output and Xn stands for exogenous factors like broiler feed, medication, and electricity cost. In other words, the rate at which these exogenous inputs are converted into end products is described by the production function (single output, Y). The domain of this function is all values of x larger than or equal to zero. Each output level (y) that results from each level of input (x) used make up the function's range (Debertin, 2012). The decisions made by farmers regarding what to produce, how to produce it, and how much to produce are influenced by both input and output pricing. The most pertinent metric in this situation is the output-input price ratio (Johl & Kapur, 1987). To find the total agricultural supply response, the output-input price ratio as represented by agricultural terms of trade is more pertinent (Palanivel, 1995). Only when agricultural production is highly responsive to rising prices can higher agricultural growth be realised (Bhalla, 1994). Economic reforms' effects on rural employment also rely on how much the agricultural supply is responding (D'Souza, 2001).

2.11.1 Supply and Elasticities Theory

Typically, supply is thought to be made up of imports, stocks, and domestic production. Ceteris paribus, the schedule of quantities that farmers are willing to produce at various predicted price levels is referred to as the farm supply (Ferris, 1998). Furthermore, elasticities, which measure how responsive an independent variable is to a percentage change in the dependent variables, are a practical way to communicate linkages within the supply chain (Calcaterra, 2002). As was already established, econometric studies often focus on four different forms of elasticities: own price elasticity, cross-price elasticity, input elasticity, and income elasticity.

The shape of the supply curve is described by the concept of elasticity, according to Sartorius von Bach and Van Zyl (1990) who defined a supply curve as a timetable outlining the amounts that producers are willing to offer at a particular price, time, and location. However, in agriculture, supply analysis should be approached in a different way, whereby in broiler production, one has to consider the number or the expected broilers to be slaughtered versus the average price of the broiler at a particular point in time. The length of time it takes producers to adapt to changes affects the slope of the supply curve. The law of supply states that if a product's price rises, its supply should follow suit (van Wyk, 2011).

The relationship between a change in quantity supplied and a price change is measured by the price elasticity of supply. As a result, it describes how a marginal value and an average value relate to one another (Debertin, 2012). The sensitivity of the quantity supplied to a change in the goods price is indicated by its price elasticity of supply.

The quantity supplied is less sensitive to price changes when there is inelastic supply (Abowd, 1998). The relationship that an elasticity depicts is referred to as inelastic when it is little (between 0 and 1 in absolute value) and elastic when it is high (greater than 1 in absolute value). On the other hand, elasticity equal to one is referred to as unit (or unitary) elastic.

2.11.2 Agricultural Supply Response Theory

The concept of agricultural supply response functions to elaborate the behavioural response of farmers to changes in price and non-price factors, while the degree of responsiveness of producers

to changes in the price of a particular product is measured by their price elasticity of supply (Adeyemi, 2019). Any model that produces outputs from inputs has its restrictions and issues. According to (Von Bach *et al.*, 1992), common issues in supply response studies include, uncertain expectations, technological changes and measurement of the influence of the weather.

Rational price sensitivity by producers would presuppose desirable responses to changes in prices. Conversely, insensitive producer behaviour is construed as insignificant or lacking output responsiveness despite notable changes in prices (Ajetomobi, 2010). A farmer's production behaviour or supply response is determined by both price and non-price factors. Price factors include output prices and input costs. The non-price factors include exogenous technology shifters and biophysical conditions such as rainfall, irrigation, market access, investment and education.

Prices of agricultural goods are influenced by macroeconomic policies such as trade, exchange rate and fiscal policies via their impacts on the real exchange rate. Prices of agricultural goods and non-price factors inclusive of exogenous shocks influence agricultural production in a form of yield or acreage or product. Relative changes in agricultural prices determine farmers' investment decisions, productivity and income. Thus, understanding the factors that influence price is fundamental for sustainable growth in this sector and the rest of the economy (Asfaha & Jooste, 2007).

Agricultural economics literature within the second half of the 1970s showed consideration in respect of the effect of macroeconomic factors on the agricultural sector (Asfaha & Jooste, 2007). There is a significant linkage between money supply, exchange rate, interest rate and agricultural prices and high agricultural price volatility caused by macroeconomic policy changes might increase the uncertainty amongst farmers and this eventually affects their investment decisions, particularly on production and the level of farm income. The slow speed of adjustment of industrial prices to monetary changes adds to overshooting in agricultural prices (Asfaha & Jooste, 2007).

Previous research has argued that the majority of developing countries experience unfavourable prices for agriculture (Haile *et al.*, 2016; Jongeneel & Gonzalez-Martinez, 2020). They contend that unfavourable terms of trade are largely to blame for slow agricultural growth and the ensuing issues of poverty, the balance of payments disequilibrium, and slow overall growth because they

believe that both private and public resources allocated to agriculture are highly responsive to prices.

2.11.3 Supply Shifters

It is critical to distinguish between shifts in supply and changes in supply amount. According to economic theory, a change in quantity supplied is a result of a change in the price of a product represented as a change in position along the supply curve, ceteris paribus. A change in one or more of the supply influences causes a shift in supply (such as technological advances, weather, institutional factors and so forth). As a result, in addition to the prices of agricultural inputs and outputs, several other factors, such as the price and availability of consumer goods, farm subsidies and taxes, research, extension, road infrastructure, and services like marketing or credit, also have an impact on the quantity supply (Shoko, 2021).

In corroborating the above, Kanwar (2006), demonstrates that the weather (particularly rainfall), input availability (specifically irrigation, fertilizer, and enhanced seeds), and relative profitability, in that order, all affect the supply response of the Indian food crops. These findings led to the conclusion that, to significantly boost the long-term yield of food crops, policy agencies should focus on increasing the provision of assured irrigation, fertilizer, and improved seeds. These factors are probably going to have a big beneficial impact on how well the food crops produce. Haile *et al.* (2016), further discovered that the global acreage reaction to prices and price risk was comparable to the global short-term yield response. Although yields respond to output/input price ratios, other non-price elements are also recognised to be significant, including weather and technology advancements plus genetic advances, better management techniques, infrastructure investments, and finance availability.

Furthermore,Ogazi (2009), demonstrated that the pricing policy in the form of economic incentive alone is not a suitable instrument for influencing the response of domestic rice producers in Nigeria. To improve the yield from Nigerian rice farmers, a better policy package that includes both economic and non-economic incentives, as well as efficient transmission mechanisms, may be essential.

2.12 Econometric Models on Supply Response

Supply response to prices and non-price factors can be measured in two broad approaches namely, programming and econometric model. These two methodological techniques have been moving closer to each other during the last few decades, although they maintained that economic hypotheses and objectives have not changed (Heckelei & Wolff, 2002). Linear programming/optimisation is a technique used to determine solutions such as profit maximisation or lower cost, given a set of variables that are represented in a form of a linear relationship (Adeyemi, 2019).

The benefits of this method are that complex multi relationships in the production system are better examined through linear programming. However, data requirements are extensive: a collection of data at the farm level can be costly and the development of such models takes a long time. Due to the restricted data and resources that are available, this approach is not preferable to researchers when supply response studies are conducted (van Wyk, 2011).

Agricultural output is not immediate and is a function of post-investment decisions that were taken and expected. From a practical perspective, production in any period or season is affected by past decisions of the previous production cycle.

According to Adeyemi (2019), the following categories of supply response models are found in the literature on applied production economics:

Adaptive expectation (Nerlove, 1958a)

Partial Adjustment (Nerlove, 1956)

Distributed Lags (Askari & Cummings, 1977, Nerlove, 1958b)

Endogenous land allocation (Nerlove, 1979)

Rational expectation (Eckstein, 1985)

Error correction (Hallam & Zanoli, 1993)

2.12.1 Partial adjustment model

With the use of this model, agricultural producers may predict how demand and supply will progressively change in response to shifting production environments to reach new equilibrium levels (Sadoulet *et al.*, 1996). The partial adjustment lagged model is popular among researchers like Rao and is thought to be suitable for crop farmers (Shoko, 2021).

2.12.2 Adaptive expectation model

According to Shoko (2021), decision-making in farming is represented by many processes for developing price expectations. When deciding what crops to plant and on how much land, producers must take output prices into account. These values are unknown at the time of planting. The naive and adaptive expectation theory fails to take into account the dynamics of price expectations among decision-makers (Nichell, 1985).

The following is how the simple adaptive expectations model was created:

$$\boldsymbol{Y_t=\theta_0+\theta_1 P_{t-1}+\theta_1 Y_{t-1}+\mu_t}$$

Y_t= dependent variable

P_{t-1}= price variable

$\mathrm{Y_{t-1}} = \text{output in period } \mathrm{t-1}$

2.12.3 Distributed Lag models

According to this concept, the price from the preceding period determines the present supply of agricultural products (Sadoulet & de Janvry, 1995). According to Gwara (2011), farmers use the current prices to alter their supply. To put it simply, this model suggests that farmers have unrealistic expectations about the prices. However, a higher output would result in lower pricing the following year, and the cycle would continue in a cob-web-pattern. Therefore, production adjustment is not immediate but may take some time for it to be noticed in the market.

The expression of this relationship is as follows;

$$\boldsymbol{Y_t=\alpha+bP_{t-1}+\mu_t}$$

2.12.3.1 Auto Regressive Distributed Lag (ARDL) Model

Pesaran and Shin introduced and created the ARDL approach then Pesaran *et al.* (2001), improved it a few years later. As it offers various advantages over conventional statistical approaches for evaluating cointegration and short/long-run relationships, the ARDL method has been widely applied (Larsson & Haq, 2016). According to Duasa (2007) and Adom *et al.* (2012), ARDL can be used to test for a level relationship for variables that are either I(0) or I(1) or for a combination of I(0) and I(1) variables. The ARDL model does not impose the constrictive requirement that all of the study's variables be integrated into the same sequence, unlike other co-integration procedures (van Wyk, 2011). Even in situations where some of the variables are endogenous, the ARDL technique is renowned for offering unbiased long-run estimates (Adom *et al.*, 2012). To evaluate the combined significance of the coefficients of the lagged level independent variables, the F-statistic [Wald-test] is computed in the first step using the estimation of the ECM, and this is the first stage of the ARDL approach to co-integration analysis. Making decisions on the amount of endogenous and exogenous variables to include in the supply model and the time lags relevant to each variable is another challenge that the ARDL approach avoids. The ARDL technique enables the supply model to incorporate various variables with various optimal numbers of lags (Ogazi, 2009).

Many benefits of ARDL over traditional Johansen co-integration methods have been asserted. Firstly, whilst the Johansen co-integration techniques still require large data samples for validity, the ARDL is a more statistically significant method for finding co-integrating correlations in small samples. Another benefit is that the autoregressive distributed lag approach captures both short-run and long-run dynamics when testing for the presence of co-integration, whereas other co-integration techniques require all regressors to be integrated into the same order. This approach also solves some of the issues associated with other co-integration techniques. The ARDL avoids employing the Johansen co-integration technique because of the overwhelming quantity of options available (Ogazi, 2009).

2.12.4 Nerlovian Model

The Nerlove model, which incorporates price expectations and/or adjustment costs to describe the dynamics of agriculture, is the foundation for the majority of empirical estimates of agricultural supply response. The distributed lag model, the partial adjustment model, and the adaptive expectation model are all combined in this model (Gwara, 2011). To account for incomplete information on these variables, this model can be expanded to incorporate expectational factors other than price (Muchapondwa, 2009).

2.12.4.1 Nerlove Model specifications

The general static supply function can be mathematically presented as:

$$\boldsymbol{Y_t^*=\alpha + \beta_1 P_{t-1} + \beta_2 Z_{t-1} + U_t} \quad \textbf{...(1)}$$

Y_t is the actual output in the period t (tons/year)

Y_{t-1} is the actual output in period t-1(tons/year)

Y_t^* is the expected output in the period t (tons/year)

Y_{t-1}^* is the expected output in period t-1 (previous years tons/year)

2.12.4.2 Shortcomings of the Nerlovian Model

The Nerlovian model provided the ability to account for price expectations and cost adjustments when estimating supply response. However, the Nerlovian model has the drawback that it might produce erroneous (misleading) regression findings when there is a unit root problem in a data set or series (McKay *et al.*, 1999). Because of the potential for erroneous regression due to time series non-stationarity and ad hoc assumptions, this approach has drawn a lot of criticism (McKay *et al.*, 1999).

Due to these drawbacks, the current study makes use of cutting-edge econometric methodologies analysis that may estimate discrete short-run and long-run elasticities to get around the common issue with the conventional Nerlovian model (Ogazi, 2009). According to Shahzad *et al.* (2018), one has to verify the R-square and Durbin Watson values to spot erroneous results. The model is deemed bogus if the R-square value exceeds the Durbin Watson value.

It is impossible to distinguish between short-run and long-run elasticities using the Nerlove formulation. The fundamental flaw in the partial adjustment model is that it makes the erroneous

assumption that the target supply is fixed and based on stagnant expectations. Therefore, unless certain subjective limits on one or the other are enforced, a Nerlovean formulation makes it impossible to discern the corresponding coefficients when both partial adjustment and adaptive expectations are present (Muchapondwa, 2009).

2.13 Recent Studies on Supply Response

In South Africa, for example, a study by Shoko (2014), that examined the reaction of the maize supply indicated that maize farmers are more responsive to nonprice factors than price considerations.

Using a partial adjustment model, Begum *et al.* (2002), investigated the supply response of wheat in Bangladesh between 1972–1973 and 1998–1998. They calculated Bangladesh's short- and long-term supply elasticities as well as the reaction of wheat to the chosen factor. They discovered that wheat supply had both short- and long-term significant price reactions, and that the supply's response to factor-lag irrigation was relatively strong. Short-term and long-term price responses of wheat supply were 0.67 and 1.06, respectively. They argued that the government's policy of price stabilisation and farm price assistance might enhance Bangladesh's supply of wheat.

van Wyk (2011), conducted a study to examine the connections between the various price and non-price elements influencing the supply dynamics in the Namibian mutton market.The study revealed that the average mutton producer price in Namibia has a substantial long-term association with the supply of mutton.

Ogundeji *et al.* (2011), investigated the supply response of beef in South Africa. The study revealed that South African beef producers in the long run adapt to economic, climatic, trade, and demographic issues. However, the paper demonstrates that, in the short term, imports of beef and environmental variables (such as rainfall) have an impact on animals marketed for slaughter. The study further reveals that the characteristics of the animals, the producer price of yellow maize, and the producer price of beef did not have a short-run impact on cattle marketed for slaughter.

A study was conducted by Gosalamang (2010), where the supply response of cattle farmers in Botswana was estimated using the Nerlovian partial adjustment model. It was then revealed that

price elasticity in the short run was 1.511, whereas elasticity over the long run was 1.057. This was a blatant indication that Botswana's price strategies are successful in achieving the intended amount of beef output. Furthermore, price hikes must be implemented going forward as a tactic for increasing the supply of cattle.

2.14 Chapter Summary

In summary, the consumption and demand for broiler meat globally has been increasing. This reflects the cheaper cost of chicken as compared to other meats. It has been revealed that Brazil is one of the top producers of broiler globally, and this country has a comparative advantage in terms of maize and soya production as compared to South Africa. In South Africa, currently, there is a high demand for the broiler and given the challenges in the industry, the local production cannot match the demand. Since the industry is highly integrated, penetration into the market and high capital requirement still pose challenges.

The high levels of import penetration in the local market have alarmed the poultry sector in South Africa. Contrary to US and European markets, where boneless poultry goods like breasts are popular, the local poultry market favours bone-in chicken products. Imported products face significant competition from bone-in chicken products. Despite making up the second-largest share of all imports, mechanically deboned meat (MDM) imports do not compete with domestic production: Since the local market prefers bone-in chicken parts over fillets or boneless breasts, there is not enough left over to make MDM. MDM is manufactured from the leftovers after extracting boneless meat, which is favoured in many international markets.

It has also been revealed that different methodologies can be applied to supply response studies. One of the most common is the Nerlove model, ARDL and VECM. However, the application of these models is based on compliance to certain econometric requirements. The volume of literature has grown significantly around supply response. In South Africa, arguably, there are few studies on the supply response.

3 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The chapter provides a summary of the research methodology components, including the research approach, study area, design, methodologies, and variables used in the analysis of the empirical data. The chapter also covers the methods that were employed to analyse how changes in price, and non-price factors affected broiler supply. The study used techniques that have been proven effective in previous agricultural supply response studies and econometrics literature.

Autoregressive Distributed Lag Model (ARDL) was used in this study to estimate the supply response and elasticities of broiler meat.

3.2 Description of the study area

The southernmost nation of Africa, formally known as the Republic of South Africa, is the subject of the current study. With 2,798 kilometers of the Atlantic and Indian Ocean coastline, it is divided into nine provinces. The neighbouring nations of Namibia, Botswana, and Zimbabwe are to the country's north; Mozambique and Swaziland are to the east; and Lesotho is an enclave, that is, it is surrounded by South African territory.

All around South Africa, broiler meat is produced, although the biggest producers are North West, Western & Northern Cape, Mpumalanga, and Free State account for almost 74% of the nation's total output in 2020. The provinces that produced the most broiler meat in South Africa were North West produced 23%, Mpumalanga (20%), Western & Northern Cape (18%), and Free State (13%).With only 3% of South Africa's broiler meat produced, Limpopo Province was the lowest producer (Department of Agriculture Land Reform and Rural development, 2021).

Figure 3.1*:* South African Map

Source (www.google.com,2022)

3.3 Data Sources

In this study, 144 monthly historical time series observations from secondary sources covering the years 2010 to 2021 were used. This historical time series data were collected on broiler supply, weighted average broiler price, broiler feed price index, broiler imports, and exports, and nominal exchange rate used in the study. Data on broiler supply, weighted average broiler price, broiler feed price index, broiler imports, and exports were sourced from the South African Poultry Association, (SAPA). Data on nominal exchange rate were sourced from the South African Reserve Bank.

3.4 Techniques of Data Analysis

3.4.1 Autoregressive Distributed Lag Model (ARDL)

Autoregressive Distributed Lag Model (ARDL) as an appropriate model was used in the study in line with the study objectives, and this is prompted by the limitations that were found in the Nerlovian m model as captured in the literature review.

The ARDL model was developed and introduced in 1998 by Pesaran and Shin and got refined by (Pesaran *et al.,* 2001). The dynamics among variables can be assessed through the use of the ARDL model. ARDL model allows the usage of fairly medium/large samples and secondly, hypothesis testing is utilised to ascertain the significance of long and short-run relationships between

variables. In addition to describing the integral relationship between the dependent and explanatory variables in both the short- and long-terms, the ARDL technique may be used to describe the complementary relationship between the dependent and explanatory variables (Eliw *et al.*, 2019).

The model is specified as follows:

$$\Delta lbs_t = \beta_0 + \beta_1 lbs_{t-1} + \beta_2 lbpi_{t-1} + \beta_3 lbim_{t-1} + \beta_4 lbex_{t-1} + \beta_5 ner_{t-1} + \beta_6 D_{t-1} + \beta_7 labp_{t-1} + \sum_{t=1}^{p} \delta_{1i} \Delta lbs_{t-i} + \sum_{j=0}^{q} \delta_{2i} \Delta lbpi_{t-j} + \sum_{k=0}^{q} \delta_{3i} \Delta lbim_{t-k} + \sum_{m=0}^{q} \delta_{4i} \Delta lbex_{t-m} + \sum_{n=0}^{q} \delta_{5i} \Delta ner_{t-n} + \sum_{r=0}^{q} \delta_{6i} \Delta D_{t-r} + \sum_{v=0}^{q} \delta_{7i} \Delta labp_{t-v} + \varepsilon_t$$

Where the dependent variable (*lbs*) is the log of broiler supply

Where independent variable (lbpi) is the log of broiler feed price index

Where independent variable (lbim) is the log of broiler imports

Where independent variable (lbex) is the log of broiler exports

Where independent variable (labp) is the log of weighted average broiler price

Where independent variable (ner) is the nominal exchange rate

Where independent variable (d), the dummy variable which measures the impact of the outbreak of disease on the supply of broiler.

The long-run coefficients are captured by $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ while the short run effects are measured by $\delta_{1i}, \delta_{2i}, \delta_{3i}, \delta_{4i}, \delta_{5i}, \delta_{6i}, and\ \delta_{7i}$

3.4.2 Estimation of Speed of Adjustment using Vector Error Correction Model

The Error Correction Model (ECM) is commonly used to estimate dynamic co-integrated systems. Estimating the speed of adjustment towards the long-run equilibrium level is another crucial challenge for the structural ECM. At least, one linear combination of variables adjusts to the long-run equilibrium level with a constant rate of adjustment in a structural ECM. A structural ECM's speed of adjustment coefficient differs from its reduced form of ECM's speed of adjustment coefficient in general (Kim *et al.*, 2003). Error Correction Models are a class of models that provide insight into the long-term relationship between variables in terms of the propensity, long-run propensity and lag distribution for Δy as a distributed lag in Δx where the independent variable is x and the dependent variable is y (McGowan Jr & Ibrahim, 2009).

Error Correction Term (ECT) is computed based on the past values of both x and y. If the past values of y are overestimated, future values will be moved back towards equilibrium by the error correction factor (Gwara, 2011). The basic advantage of using the Vector Error Correction Model (ECM) to model supply response studies is how it avoids the partial adjustment model's unrealistic assumption of fixed target supply based on stationary expectations (Gwara, 2011).

Subsequently, the study examined the error correction model to ascertain the possibility of the speed of adjustment to long-run equilibrium. The following model expresses the error correction model:

$$\Delta lbs_t = \alpha + \sum_{i=1}^{p} \theta_{1i} \Delta lbs_{t-i} + \sum_{j=1}^{q} \omega_{1j} \Delta lbpi_{t-j} + \sum_{j=1}^{q} \omega_{2j} \Delta lbim_{t-j} + \sum_{j=1}^{q} \omega_{3j} \Delta lbex_{t-j} + \sum_{j=1}^{q} \omega_{4j} \Delta ner_{t-j} + \sum_{j=1}^{q} \omega_{5j} \Delta D_{t-j} + \sum_{j=1}^{q} \omega_{6j} \Delta labp_{t-j} + \gamma ECT_{t-1} + \varepsilon_t$$

Where $\theta \; and \; \omega$ capture the short-run coefficients while γ measures the speed of adjustment of the model. The lag lengths are respectively p and q and ε_t is the white noise error.

3.4.3 Quantifying the supply response to changes in broiler meat prices of broiler producers using the Auto Regressive Distributed Lag model (ARDL)

The ARDL model was applied to quantify supply response by assessing independent variables that have a relationship with the dependent variable. Estimating the ARDL model's long-run and short-run elasticities is the second stage. This method is used to determine whether there are any long-term correlations between supply output and the variables that affect supply (van Wyk, 2011).

3.4.4 Estimating supply response of broiler producers to changes on price and non-price factors using the ARDL model.

The ARDL model was used to estimate supply response to price and non-price factors.

3.4.5 Determining the price elasticity of supply of broiler in the long and short run using ARDL co-integration

The ARDL c-ointegration analysis was used to provide a way to get separate estimates of the long-run and short-run elasticities.

3.5 The ARDL Bound Test

Even in the presence of regime shifts and shock, the ARDL bounds test is robust for finite samples. One Zero dummy variable can be applied to the phenomena. A conclusion on co-integration among variables can be drawn with these dummy variables (Fuinhas & Marques, 2012).

3.5.1 Descriptive statistics

Measures of dispersion and central tendency were used in the investigation. Mean, maximum, minimum, standard deviation, and variance are some of the measurements. The average gauges the strength of the central tendency. It is calculated by putting all of the observations together, then dividing the result by the total number of observations. The highest and lowest values are represented by the maximum and minimum measurements, respectively. Observations were presented as percentages of one hundred. Then, 53 quartiles and percentiles provide for data grouping. Data dispersion was also calculated using standard deviations. It was obtained by calculating the variance's square root. Bar graphs, line graphs, tables, and pie charts were all used as summary tools.

3.5.2 Unit Root Test

The study used the Philips Perron and the Augmented Dickey-Fuller (ADF) tests to describe the stationarity of the variables. Generally, the determination of the stationarity of the variables will help to avoid the incidence of spurious regression. To prevent the issue of false regression in the predicted coefficients, unit root tests make sure the data is stationary. A data point displays a trend if it is non-stationary. On non-stationary data, the standard OLS regression might result in erroneous inferences and conclusions. Therefore, the trending element in the data series needs to be removed (or de-trended) (Adeyemi, 2019). According to Zivot and Wang (2006), the first differentiating and time-trend regression are two common methods for de-trending or trend elimination. For l (1) time series, first differencing is appropriate and for trend stationary I(0) time series, time trend regression is relevant.

According to Shoko (2021), the Augmented Dickey-Fuller test (ADF), which requires fitting a regression of the form, is used by the majority of time-series studies

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \delta_t + \varphi_1 \Delta Y_{t-1} + \varphi_k \Delta Y_{t-k} + \mu_t$$

β is the coefficient of the Y_{t-1}

ΔY_t ***is the first difference operator of*** Y_t, Y_{t-1}

An alternate method for examining the presence of a unit root in a broad time series was created by Phillips and Perron in 1988. The primary areas where the Phillips-Perron (PP) unit root tests and the ADF tests diverge are in their approaches to serial correlation and heteroscedasticity in the errors (Adeyemi, 2019).

This model tests in the following form:

$\Delta Y_t = \pi Y_{t-1} + \beta D_{t-1} \delta_t + e_t$

Where e_t ***is*** $I(0)$ ***with zero mean***

D_{t-1} **is a deterministic trend component**

The hypothesis is tested for $\pi = 0$

According to Shrestha and Bhatta (2018), the main distinction between the PP test and the ADF test is that the PP test is a non-parametric test, therefore, it is not required to describe the form of the serial correlation of ΔY_t under the null hypothesis. Additionally, PP adjusts the statistics to take into account the problems with autocorrelation and heteroskedasticity. Comparable to the ADF test, the hypothesis testing process is similar.

If a time series variable does not show an upward or downward trend across time, it is said to be stationary. Economists usually concentrate on a single sort of non-stationarity namely, unit root non-stationarity (KOOP, 2009). Most macroeconomic time series data are non-stationary in nature (Brooks, 2008). In this study, the use of a unit root test is necessary to prevent the aforementioned problems (Brooks, 2008). Dickey-unit Fuller's root test is one way to check for stationarity (1979).

3.5.2.1 Framework for selecting an appropriate and suitable analytic model

The fundamental framework and criteria utilised to choose the best time series methodology for this investigation are shown in Figure 3.2. The unit root test results, which establish the stationarity of the variables, serve as the basis for the model selection criteria, which were borrowed from (Shrestha & Bhatta, 2018).

Shrestha and Bhatta (2018), indicate that unit root testing is the initial phase in the time series analysis process. The OLS method can be used to ascertain the relationship between the provided variables if the results of the unit root test demonstrate that all the variables under analysis are stationary. Methods often used to analyse stationary time series cannot be applied to non-stationary

series (Shrestha & Bhatta, 2018). However, vector autoregressive (VAR) or ordinary least square (OLS) models can offer unbiased estimates if all the relevant variables are stationary. OLS or VAR models might not be appropriate if all the variables are non-stationary. As shown in Figure 3.2, the ARDL model becomes an appropriate method to handle time series data with such qualities when variables employed in the analysis have mixed order of integration, that is, some are stationary and others are not.

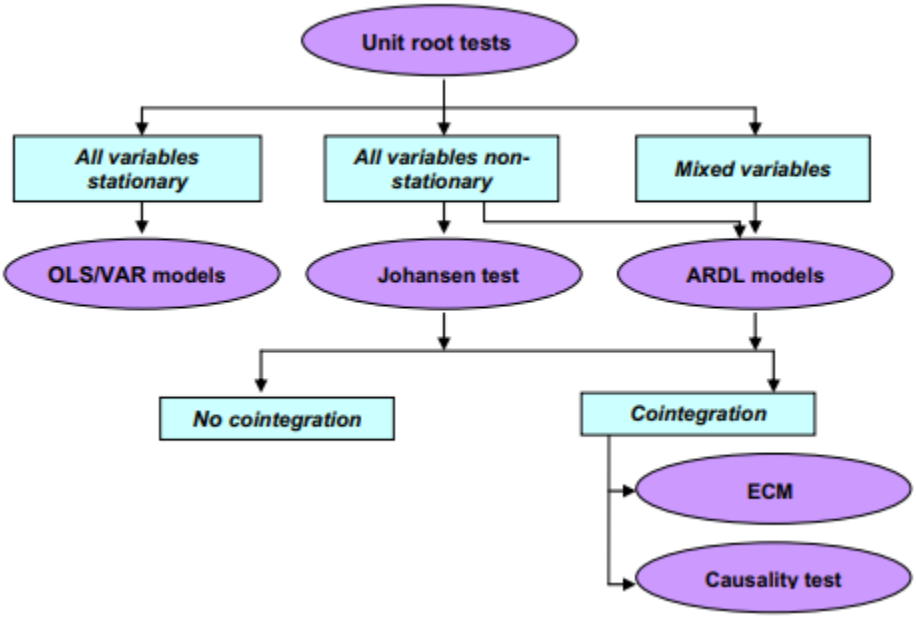

Figure 3.2 Framework for selecting an appropriate and suitable analytic model

Source (Shrestha & Bhatta, 2018)

3.6 Diagnostic Test

In this study, diagnostic statistics test was applied. By examining goodness of fit statistics and doing diagnostic tests, we can assess the fitness of the model and make it more reliable and objective (Shrestha & Bhatta, 2018). The type of diagnostic test is determined by the modelling approach being used. However, lag structure, coefficient diagnostics, and residual diagnostics are the three most popular forms of diagnostic testing. Since regression models attempt to reduce errors, residual diagnostics is the most important component of diagnostic tests in economic modeling (or residuals) (Shrestha & Bhatta, 2018).

3.6.1 Normality Test

To determine whether a sample is taken from a normal distribution or not, numerous statistical methods have been developed. Based on the traditional metrics of skewness and kurtosis, the Jarque-Bera test was developed. This test has a zero-breakdown value since these measurements are based on moments of the data. In other words, a single outlier has the power to invalidate an entire test (Brys *et al.*, 2004). The Jarque Bera statistic describes the normality of the distribution. It is an asymptotic or large sample test that is based on OLS residuals. The test initially generates the skewness **coefficients, S** (a measure of the asymmetry of the Probability Density Function), and kurtosis**, K** (a measure of how tall or flat a Probability Density Function is relative to the case of normality. JB statistic will be zero provided the distribution of a variable is normal but if variables are not normally distributed, JB statistic will assume increasing larger values (Gujarati *et al.*, 2012).

According to Brys *et al.* (2004), skewness and kurtosis refer to a distribution's third and fourth moments, respectively. A distribution's asymmetry is characterised by skewness. Asymmetric distributions with the greatest right tails have positive skewness, whereas those with longer left tails have negative skewness. A symmetric distribution has zero skewness.

The skewness is defined as follows for every distribution F with finite central moments μ_k (K≤ 3), the skewness is defined as follows:

$$\boldsymbol{\gamma_1(F)} \frac{\boldsymbol{\mu_{3(F)}}}{\boldsymbol{\mu_2(F)^{3/2}}}$$

The kurtosis is defined as the following for any distribution F with finite central moments μ_k (K≤ 4),

$$\boldsymbol{\gamma_2(F)} \frac{\boldsymbol{\mu_{4(F)}}}{\boldsymbol{\mu_2(F)^2}}$$

The problem of serial correlation characterises a time series provided the errors at a specific period correlate with subsequent periods. The Breusch - Godfrey LM test was applied in this instance.

3.6.2 Testing for Multicollinearity

Multicollinearity is the linear relationship between two or more variables; it also refers to the absence of orthogonality between the variables. It is a data issue that could seriously undermine the accuracy of estimations of the model parameters (Alin, 2010). The test of multi-collinearity becomes crucial to check for the possibility of linear dependence among the variables. For instance, Daoud (2017) asserts that multi-collinearity characterises a regression model provided two or more explanatory variables are correlated in a regression model. Specifically, the variance inflation factor measures the multi-collinearity based on regressing an explanatory variable on other explanatory variables in a model (Halcoussis, 2005). Moreover, the VIF is expected to be at most four to avoid the severity of multi-collinearity with further information that the VIF will exceed four provided the R^2 of regression an explanatory variable on other explanatory variables exceeds 0.75 (Gosalamang, 2010).

As a multicollinearity diagnostic, the variance inflation factor (VIF) is provided as follows;

$$\boldsymbol{VIF_i = \frac{1}{1-R_i^2}} \textbf{ for I = 1,2…….,k}$$

R^2 is the coefficient of multiple determination of x_i on the remaining explanatory variables. When compared to the variance that would be produced if there were no multicollinearity. The more the VIF inflates, the larger it is. A high value of VIF indicates that at least one linear dependency exists for xi, but it does not specify which xi. 10 is typically used as the threshold value to distinguish small from substantial deviations. A multicollinearity index that is also utilised is the mean of the VIF values. A mean that is significantly bigger than one indicates multicollinearity.

3.6.3 Test for Heteroskedasticity

According to Porter and Gujarati (2010), an important assumption of the classical linear regression model (CLRM) is that the disturbance μ_i entering the population regression function (PRF) are homoscedastic; that is, they all have the same variance. If this is not the case- if the variance of μ_i is δ_i^2 indicating that it is varying from the observation to observation (notice the subscript on δ^2). Symbolically, heteroscedasticity is expressed as follows;

$$\boldsymbol{E(\mu_i^2) = \sigma_i^2}$$

The subscript on δ^2, which is a reminder that the variance of μ_i is no longer constant but varies from observation to observation. According to researchers, time series data rarely contain

heteroscedasticity; however, cross-sectional data typically do (Porter & Gujarati, 2010). When the OLS regression coefficients have the lowest variances of all the unbiased estimators that are linear functions of the observations of Y, then, heteroscedasticity does not exist, but when OLS estimators are inefficient because it is possible to find other estimators that have smaller variances and are still unbiased, then heteroscedasticity is present (Zilfimiam, 2019).

Stability Test

A suitable test, such as the cumulative sum of recursive residuals (CUSUM), which identifies the stability of and harmony between long and short-run parameters, should be chosen to test the stability of ARDL Models (Eliw *et al.*, 2019). The cumulative sum (CUSUM) and cumulative sum of squares (CUSUM SQ) tests, are used to determine whether the used data are free of any structural alterations in the study (BENTOUMI & GAIDI, 2020).

3.7 Data Analysis

The analysis was conducted using STATA 14, with the best lag lengths selected following the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). Some of the variables in the model are in their logarithmic transformations such as the dependent variable (lbs) and other explanatory variables comprising of lbpi, lbim, labp and lbex. The disease dummy variable and nominal exchange rate were the only variables that were not stated in natural logarithms.

To obtain a series' variance that is more homogeneous, the log transformation is used (Lutkepohl & Xu, 2009). The ability to explicitly interpret each explanatory variable's coefficient as short-run elasticities provided by the transformation also supports the use of the log transformation. Therefore, it implies that the respective coefficient for these variables measures the elasticity with respect to broiler supply.

3.8 Chapter summary

In summary, this chapter concentrated on outlining the research techniques that were applied to each of the study's research objectives. The methods and procedures used for data analysis were covered in detail. The research topic, sample duration, and data sources were also disclosed in the chapter. The framework for selecting an appropriate and suitable analytic model was discussed in detail to guide the content in Chapter Three. The suitable model which is the ARDL model was acknowledged

based on the framework. A step-by-step procedure for analysis was also outlined in the chapter. The results and discussions will be done in Chapter Four, guided by the methodology in Chapter Three.

4 CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

By utilising ARDL model, this section contributes to the body of literature (methodology) about the supply response of broiler producers in South Africa. The first section of this chapter, which is divided into three parts, gives an overview of the variables employed in the research. Descriptive statistics, unit root tests and diagnostic tests are also used. Firstly, variables and data utilised for the model are described using descriptive statistics then followed by unit root testing, diagnostic test and ARDL analysis to estimate both long- and short-term supply elasticities The empirical findings and discussions are presented in the second section. The findings of the empirical study of broiler supply response analysis are presented in Chapter Four.

Table 4.1: Descriptive statistics results

Table 4.1 provides descriptive statistics on the respective variables. It can be observed that all the variables maintained internal consistency because their respective means lie between the minimum and the maximum values. Moreover, the normality of the respective variables can be explained by the skewness and kurtosis. The results show that variables lbpi, lbim and labp are negatively skewed while that of lbs, lbex and ner are positively skewed. All the variables are approximately normally distributed considering that they are around zero, except lbex which has a skewness of 2.216374. Corroboratively, it can be observed that lbex, lbpi and lbim have kurtosis that is approximately three, suggesting a normal distribution, while ner and labp are approximately two. However, lbex appears not to be normally distributed. Nevertheless, the subsequent econometric analysis in this study proves the reliability and stability of the model.

Table 4.1 Descriptive statistics

Variable	Mean	Std. dev	Minimum	Maximum	Skew.	Kurt
Lbs	7.905479	.0344296	7.802805	7.980174	.0005964	2.916279
Lbpi	3.684716	.102653	3.454731	3.855899	-.6005798	2.850808
Lbim	7.532177	.1217666	7.199042	7.793106	-.5387947	2.896067
Lbex	6.674271	.1135633	6.459719	7.430542	2.216374	15.32383
Ner	109.5651	25.03125	74.3	164.69	.8313764	2.370079
Labp	1.262834	.1042466	1.06988	1.454595	-.2396176	1.881867

Source: Authors compilation from Stata 14, 2022

4.2 Unit root test and Lag Length Selection Criteria

The stationarity of the respective variables used for the study was examined through the Augmented Dickey-Fuller (ADF) and Phillips – Perron unit root test. When working with variables that are integrated into distinct orders, I(0), I(1), or a combination of both, the ARDL co-integration technique is preferred. It is also resilient when there is just one long-term link between the underlying variables (Nkoro & Uko, 2016). Therefore, this combination supports the use of the ARDL model in the study.

Table 4.2 Unit Root Test results

Series	**Augmented Dickey Fuller Test [A]**				**Phillips Perron Test Test [B]**				Result [A]	Result [B]
	Level		**First Difference**		**Level**		**First Difference**			
	T –Test	Prob. Value	T -Test	Prob. Value	T -Test	Prob. Value	T -Test	Prob. Value		
NER										
Constant			-6.576*	0.0000			-9.704	0.0000	I(1)	I(1)
Constant and trend			-6.633*	0.0000			-9.686	0.0000	I(1)	I(1)
LBS										
Constant	-2.241	0.0133			-7.468	0.0000			I(0)	I(0)
Constant and trend	-3.905	0.0119			-11.640	0.0000			I(0)	I(0)
LBPI										
Constant			-3.638	0.0002			-3.573	0.0006	I(1)	I(1)
Constant and trend			-3.640	0.0266			-3.574	0.0032	I(1)	I(1)

LBIM										
Constant	-2.713	0.0038			-4.297	0.0005			I(0)	I(0)
Constant and trend	-11.756	0.0000			-5.527	0.0000			I(1)	I(0)
LBEX										
Constant	-6.035	0.0000			-8.570	0.0000			I(0)	I(0)
Constant and trend	-6.669	0.0000			-9.243	0.0000			I(0)	I(0)
LABP										
Constant			-9.851	0.0000			-11.189	0.0000	I(1)	I(1)
Constant and trend	-4.838	0.0004			-4.529	0.0014			I(0)	I(0)
DLBPI										
Constant	-3.507	0.0003			-3.490	0.0083			I(0)	I(0)
Constant and trend	-3.506	0.0387			-3.490	0.0405			I(0)	I(0)
DLBIM										
Constant	-3.500	0.0003			-3.478	0.0086			I(0)	I(0)
Constant and trend	-3.500	0.0394			-3.478	0.0418			I(0)	I(0)
DLBEX										
Constant	-3.502	0.0003			-3.474	0.0087			I(0)	I(0)
Constant and trend	-3.501	0.0393			-3.474	0.0422			I(0)	I(0)

* Indicates significance @5%

Source: Authors compilation from Stata 14, 2022

Table 4.3 Lag Length Selection Criteria Test results

Variables	Schwarz Bayesian Information Criterion **(SBIC)**	**Lag**
Nominal exchange rate **(Ner**)	5.09074*	2
Log Broiler Supply (**LBS**)	-4.4953*	3
Log Broiler Feed Price Index (**LBPI**)	-5.97222*	2
Log Broiler Imports (**LBIM**)	-2.37781*	4
Log Broiler Exports (**LBEX**)	-1.60354*	1
Log Average Broiler Price (LABP)	-5.59819*	1
D	1.41819*	1
Dlbpi	1.19089*	1
Dlbim	2.64673*	1
Dlbex	2.38083*	1

*Indicates significant levels at 5 %

Source: Authors compilation from Stata 14, 2022

Table 4.3 conveys the respective lag length of the variables based on the Schwarz Bayesian Information Criterion (SBIC). Lag length is very important in the empirical study because it helps to determine the length of period that is required for a policy action to reflect on an outcome variable.

Table 4.4 Diagnostics Test Results

Source	**chi2**	**Df**	**P**
Heteroskedasticity	15.14	20	0.7682
Skewness	7.30	5	0.1991
Kurtosis	1.25	1	0.2639
Total	23.69	26	0.5936

Source: Authors compilation from Stata 14, 2022

The econometric properties of the data under consideration are displayed in Table 4.4. It can be observed that the null hypothesis that distribution is homoscedastic cannot be rejected because the *p*-value of 0.7682 exceeds 5%. The skewness and kurtosis show *p* -values that respectively exceeds 5%, suggesting that the null hypothesis that the model is not normally distributed is rejected. Therefore, the diagnostics substantiate the reliability of the estimates.

Table 4.5 Durbin's alternative test for autocorrelation

lags(p)	**chi2**	**Df**	**Prob > chi2**
1	0.302	1	0.5828

Source: Authors compilation from Stata 14, 2022

The study utilised Durbin H to examine the autocorrelation in the residual. The use of Durban H becomes crucial because the model includes the lag of its dependent variable. The Chi2 is 0.302 which lies within the bound of -1.96h1.96. Therefore, the null hypothesis of no serial correlation cannot be rejected. This is also corroborated by the *p*-value of 0.5828 which is greater than the 5% critical value.

Table 4.6 Jarque-Bera Normality Test

chi2	***p*-value**
2.241	.3261

Source: Authors compilation from Stata 14, 2022

The Jarque bera which is a test describing the normality of the distribution produced a *p*-value of 0.3261 which exceed the critical value of 5%. It implies that the null hypothesis that the distribution is normally distributed cannot be rejected.

Table 4.7 Correlation Matrix Test results

Variables	**lbs**	**lbpi**	**Lbim**	**lbex**	**ner**	**labp**
lbs	1.0000					
Lbpi	0.5857*	1.0000				
Lbim	0.3690*	0.6244*	1.0000			
Ibex	-0.1444	-0.2681*	0.0187	1.0000		
Ner	-0.4995*	-0.9095*	-0.7051*	0.2338*	1.0000	
labp	0.6165*	0.8877*	0.6787*	-0.2598*	-0.8956*	1.0000

Source: Authors compilation from Stata 14, 2022

A correlation matrix is very useful in regression analysis because it helps to examine the possibility of linear dependence among explanatory variables thus preventing multicollinearity in empirical studies. The coefficient of correlation among most of the variables is relatively low. The correlation matrix in Table 6.6 appears satisfactory considering that the multicollinearity test in Table 5.8 produced a mean VIF of **4.99,** which is not necessarily high.

Table 4.8 Multicollinearity Test

Variable	**VIF**	**1/VIF**
Ner	8.16	0.122603
lbpi	6.91	0.144705
labp	6.36	0.157114
lbim	2.31	0.432165
lbex	1.21	0.826286
Mean VIF	**4.99**	

Source: Author's compilation from Stata 14, 2022

Table 4.9 ARDL test results

R-squared = 0.6379

Adj R-squared = 0.5546

Variables		**ARDL**				
		Long Run elasticities		**Short Run elasticities**		
	Coef.	***t*- value**	***p*-value**	**Coef.**	***t*-value**	***p*-value**
lbs	-0.34081	-2.36	0.020	-.7225631	-5.43	0.000
lbpi	-.0042314	-0.02	0.982	-.0249455	-0.13	0.898
lbim	-.0717494	-0.64	0.524	.0703789	1.69	0.094
Ibex	-.0377931	-0.47	0.640	.0389737	1.81	0.073
ner	.0004128	0.53	0.598	.0002083	0.27	0.784
D	-8.811144	-0.03	0.976	7.488175	0.11	0.020
dlbpi	.9451417	0.03	0.978	-.5761216	-0.04	0.966
dlbim	1.318026	0.06	0.953	-.701322	-0.32	0.752
dlbex	-.7078391	-0.46	0.644	-.0008298	-0.00	0.999
labp	.3417542	2.16	0.033	-.1026573	-0.62	0.539
ECM				-.3408158	-2.36	0.020
Constant	2.809193	*t*- value= 2.44 *p*-value= 0.016				

Source: Authors compilation from Stata 14, 2022

The ARDL estimates in table 4.9 distinguished the behavioural performance of the explanatory variables with respect to the supply of the broiler in the short and long run.

The speed of adjustment is 34.08%, which implies that the model is stable and self-correcting every month of any deviation from long-run equilibrium. The variables jointly and significantly influence the supply of the broiler in the long run. Nevertheless, the bounds test negates this outcome. The coefficient of determination (*r*-squared) is 0.6379. This suggests that all the explanatory variables account for 63.8% variation in the supply of broiler, while about 36.2 % variation is due to stochastic disturbance term.

4.3 Results of the study in line with the objectives

The results of the study are based on the statistical analysis of the three set objectives, where the ARDL model has been used to ascertain which variables are significant to broiler supply, including short and long-run dynamins and price elasticities.

4.3.1 Objective: To quantify the supply response to changes in broiler meat prices of broiler producers in South Africa.

In quantifying the supply response to changes in broiler meat prices of broiler producers, the results of the study indicate that labp, which is the log of weighted average broiler price is found to be statistically significant only in the long run. A 1 % increase in labp stimulates lbs by 0.3417. Also, the period lag of lbs is found to result in a significant decrease in the current supply of the broiler in the short run. Such a time difference which negatively affects the current supply of the broiler could be a result of the previous unfavourable market conditions of the broiler, which subsequently resulted in a downward re-adjustment of the supply of the broiler. A unit increase in the previous supply of the broiler in the short run results in a 0.7225631 decline in lbs. Diseases were found to be significant, with a *p*-value of 0,020 in the short run. This indicates that diseases have a significant effect on the supply of the broiler in the short run. Collectively, all these variables (log of broiler imports (lbim), exports (lbex), broiler feed price index (lbpi) and nominal exchange rate (ner) have a significant effect on the supply of broiler in the short run with a *p*-value of 0.020.

4.3.2 Objective: To estimate the supply response of broiler producers to changes in price and non-price factors.

The *p*- values for the independent variables were found as follows, Broiler feed price index, (0.982) broiler imports (0.524) and exports (0.640), a nominal exchange rate (0.598) and disease (0,976), which indicate that these variables as individuals have no significant effect on the supply of broiler in the long run. However, collectively, all these variables (log of broiler imports (lbim), exports (lbex), broiler feed price index (lbpi) and nominal exchange rate (ner) have a significant effect on the supply of broiler in the short run with a *p*-value of 0.020

4.3.3 Objective: To determine the price elasticity of the supply of the broiler in long and short run.

The coefficient of the variables in the logarithmic transformed model describes elasticity. The ARDL results in Table 6 show that lbpi, lbim, lbex, and ner are inelastic either in the short run or in the long run. In identifying variables that affect the supply response of broiler producers, the study found that Weighted average broiler price, (labp) was the only variable that was significant at (p<0,005) in the long run but inelastic at 0.3417 in the long run. The elasticity of lbpi with

respect to lbs is -0.00422 in the long run but -0.0249 in the short run. That of lbim is -0.0717 in the long run, while it is 0.0703 in the short run. The elasticity stands at -0.0377 and 0.0389 in the long run, and short run respectively for lbex. Specifically, a unit increase in lbpi either in the short run and long run results in a less proportionate decrease in lbs. However, a unit increase in lbim in the long run results in a less proportionate decrease in lbs while in the short run, it results in a greater proportionate increase in lbs. lbex has a coefficient of -0.0377 in the long run, while it is 0.0389 in the short run. This means that any increase in lbex in the long run results in a less proportionate decrease in lbs, while it produces a high proportionate increase in the short run.

The broiler price elasticity of supply is 0.3417 in the long run but -0.1026 in the short run is not significant in the short run. In either period, the elasticity of broiler price in relation to the supply of the broiler is inelastic in the long run. This implies that a 1% increase in the price of the broiler results in a less proportionate increase in the supply the broiler. It further implies that the responsiveness of the supply of the broiler is inelastic to any small change in the average broiler price. It also provides information that a change in labp generates a less proportionate change in the supply of broilers. It can be observed that a 1% increase in lbpi respectively results in -.0042314 % and-.0249455% decrease in the supply of the broiler in the long and short run, though not statistically significant. Similarly, lbex and lbim respectively exhibit negative effects on the supply of broiler in the long run but positively affect the supply of broiler in the short run. However, in either period, the variables are not statistically significant.

The study included the use of dummy variables due to the outbreak of Avian Flu which occurred in June 2017. Also, lbpi, lbim and lbex were interacted with the dummy to ascertain the performance of these variables on broiler supply over this period. A unit increase in the dummy variable (D) results in 8.811 decrease in the supply of the broiler in the long run, while a period lag of it increases the supply of the broiler in the short run by 7.4881. dlbpi and dlbim were found to positively affect broiler supply in the long run. A 1 % increase in dlbpi and dlbim respectively stimulates lbs by 0.9451 and 1.3180, while in the short run, it is a decrease of 0.5761% and 0.7013% in lbs, respectively. The dummy variable dlbex negatively affects the supply of broiler in either the short run or long run, such that a 1% increase, decreases lbs by 0.7078% in the long run but 0.00082% in the short run. Nevertheless, in either the short or long run, all the dummy

variables were not statistically significant, which implies that the variations in broilers supply over this period cannot be traced to the outbreak of the Avian Flu.

Table 4.10 The Bounds Test

f- statistics	0.819
t- statistics	-2.359
I(0)	I(1)
2.14	3.30

@5% level of significance

Source: Author's compilation from Stata 14, 2022

The study used the bounds test approach to examine if the variables collectively exhibit a long-run relationship. In Table 5.10 the *f*- statistic is 0.819, which lies below the lower bound of 2.14 at the 5 % level of significance. This implies that the variables do not exhibit long-run relationships. Nevertheless, this negates the previous outcomes of long-run equilibrium relationship of all the variables as established from the Error Correction Term

4.4 CUSUM Stability Test

Aside from the previous diagnostic, the study further examined the stability of the model through the Ramsey Cusum stability test. Figure 10 shows that the residual fluctuates within the 5% bound, which implies that the model is stable.

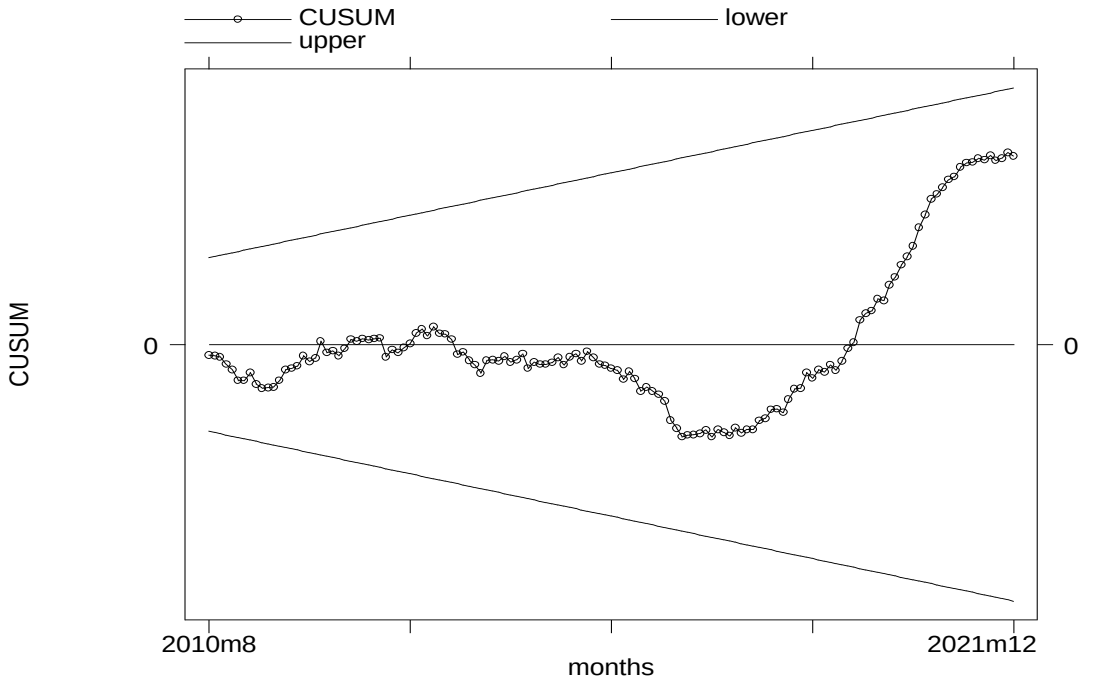

Figure 4.1 Cusum Test

Source: Author's compilation from Stata 14, 2022

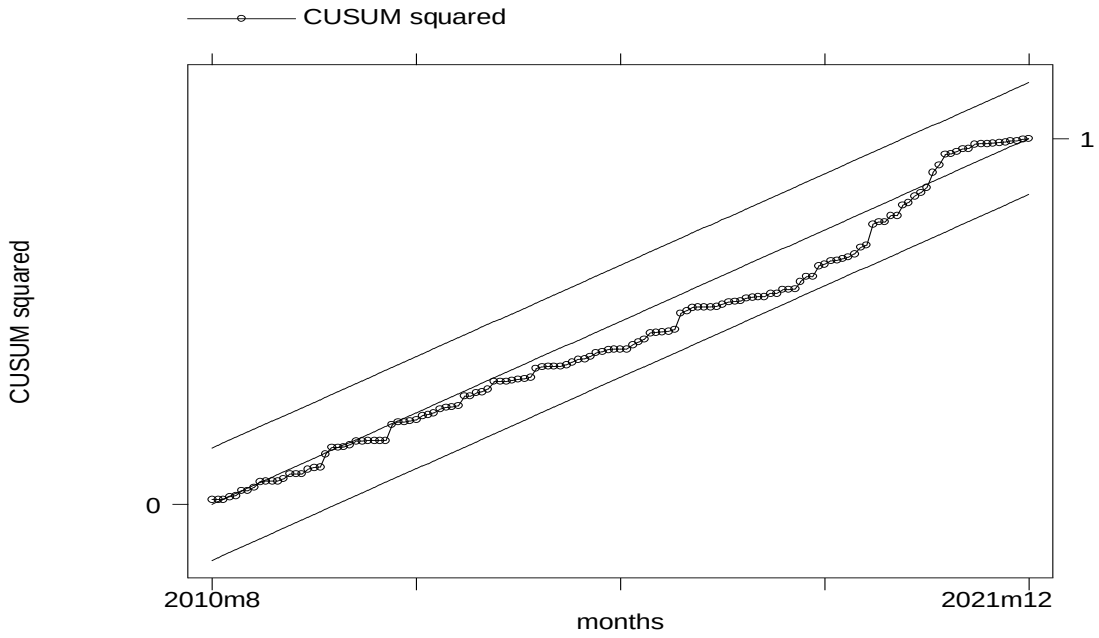

Figure 4.2 CUSUM squared

Source: Author's compilation from Stata 14, 2022

4.5 Discussion of the results

4.5.1 Significance of diseases (Avian Flu) and weighted average broiler price on broiler supply

According to the results of the study, all variables as individuals (lbpi, lbim,lbex and Ner) do not have any significant impact on broiler supply both in the short and long run except labp and D. However, collectively, all these variables have a significant impact on broiler supply in the short run. Secondly, weighted average broiler price (labp) has a significant impact on broiler supply in the long run. This corroborates with the literature by Schiff and Montenegro (1997) indicating that total agricultural supply responds well to prices. However, there are additional limitations, such as financing that prevent this response, resulting in low elasticity. The study conducted by Shoko (2014), on supply response by maize farmers indicates that the inelastic short-run and long-run price elasticities unmistakably demonstrate to us that, in addition to price variables, other non-price factors may also drive maize farmers in South Africa.

According to Shoko (2014), domestic maize supply is unresponsive to maize price given the low short- and long-term responsiveness of maize supply to own price. The transformation of price incentives to increase the supply of maize in South Africa, however, may be hampered by non-price incentives. This statement acknowledges that non-price factors may outweigh price factors in determining how decisions are made (Mythili, 2012). This study corroborates with theShoko (2014), findings on the significant impact that non-price factors have on the supply response, but the findings differ on the significance of price factors, where the price of broilers has a significant impact on supply response and study on maize supply response indicates that price is not significant.

A study on supply response on beef farmers conducted in Botswana indicates that farmers adapt to changes in both economic and non-economic aspects, and they respond well to price incentives. According to the price elasticity coefficient, increasing the price by one unit will boost cattle sales by more than one unit (Gosalamang, 2010). This study corroborates with the findings on the supply response of broiler meat, particularly on the impact of price incentives to supply.

van Wyk (2011), also confirms that price incentives are significant to mutton supply in Namibia, and this is corroborated in his results where he concludes that the key supply shifter for mutton supply in Namibia is the mutton producer price. Mutton supply is impacted by changes in the average producer price in Namibia, both favourably and negatively over time. The findings also indicated that in Namibia, the producer price of alternative goods (beef) had a short-term beneficial impact on mutton supply and a long-term negative impact. The results of the supply response analysis also demonstrated that Namibian mutton production is significantly influenced by climatological conditions, such as rainfall. In the long run, a rise in rainfall has a favourable effect on the production of mutton but a negative one in the short term. Price and non-price incentives are key to supply response based on studies conducted by Gosalamang in 2010 and Van Wyk in 2011). These corroborate with the results on broiler supply response, where broiler price and diseases are highly significant towards the supply of broiler meat in South Africa.

Diseases (Avian flu) variables in the study show a significant impact on the supply response of broiler in South Africa. According to Bureau for Food and Agricultural Policy (2018A), the outbreak of the Avian Flu in 2017 led to significant price increases, which did tempt some producers to take the risk of expanding production but also resulted in a much higher cost and decreased consumption levels. Despite the decline in production volumes, the nature of the product implies that trade has a very limited role in the domestic market.

4.5.2 The significance of other independent variables (lbpi, lbim, lbex and Ner) as collectively on broiler supply.

The study revealed that exchange rate (ner) as part of the collective variables has a significant impact on the broiler supply in the short run. According to Kidane (1999), farmers respond positively in terms of supply to devaluation by increasing the exchange rate. The supply responses in both the short- and long-run were significant. However, in our study, the supply response is only in the short term. This could be due to the short production cycle of the broiler.

Furthermore, according to the summary findings by Rouis *et al.* (1994), when it comes to price incentives, especially currency rate depreciation, aggregate agriculture supply elasticities are favourable and comparable to those in other growing economies. To decrease the early drop in domestic employment and output, some have advocated that trade and exchange transactions

should be liberalised more gradually than internal markets. Under both exchange rate regimes, producers in the majority of nations have been protected from international competition during the early phases of liberalisation. Undervaluation made it highly advantageous to look for export markets. The impact of exchange rate policy on output response, particularly for the exporting sector, is thus a very intriguing subject (Karadeloglou *et al.*, 2001).

The study also revealed that the broiler feed price index (lbip), as part of the collective variables in the model, has a significant impact on the broiler supply in the short run. The study conducted by Rezitis and Stavropoulos (2010), revealed that rising imports from other EU nations to Greece, high interest rates, falling broiler prices, and rising feed price, which is the biggest cost drivers in the broiler industry, caused substantial issues for many Greek broiler producers, and this has disrupted the production levels. The price of feed has a greater impact on broiler production than the cost of veterinary care, showing that feed is the primary cost component. The empirical findings of the current study suggest that the degree of price elasticity in the broiler supply is comparable to that found in other studies, but that the effects of price volatility and broiler feed costs are greater than those found in other studies. Since the broiler feed price index's effects are higher as compared to other variables in the model, one can conclude that high feed prices have a negative significant impact on the broiler supply response as compared to other variables in the model. This corroborates with the study conducted on the supply response and price volatility in the Greek broiler market. In corroborating the findings of this study, with the exception to the long-term effects, Hussein (2017), concluded that broiler production is more susceptible to changes in corn prices over the long term and is more likely to result in a decrease in the number of broilers raised on farms when corn prices are high. This is because the largest portion of operating costs in poultry production, between 60% and 70%, goes to feed. Due to the high cost of feed, this can harm both broiler producers, on the one hand, who are left with less profit, and consumers, on the other, who may be forced to pay more for poultry meat at the retail level due to a lack of supply.

Despite having great technical efficacy, the cost of imported soy oilcake was identified as the main obstacle to the South African broiler producer's ability to compete economically on the global market (Davids, 2013). This is corroborated by Louw *et al.* (2017), when South Africa was

compared to Brazil and the USA, and it was found that South Africa's production costs are greater, and one major reason for this is because the country imports around 90% of the soybean meal. As a result, soybean meal trades at import parity. In addition, the cost pressures encountered by local producers are increased by the prices of commodities like power and labour being regulated. However according to Farmer'sweekly (2018), the primary ingredients in broiler feed are maize meal (65%) and soybean oilcake (20%), and the profitability of the poultry sector is determined by the price correlation between yellow maize and broiler meat. According to the statement above, maize is the key determinant of broiler price, and not soybean oilcake and when the cost of feeding is low as a result of the lower maize prices, the profitability of the broiler sector is increased. The price of broilers increases, which ultimately has positively impacted the favourable price ratio.

Broiler import as part of the collective variables in the study shows a significant impact on the supply response of the broiler in South Africa. This is because South Africa is a net importer of the broiler, the sector is connected to global markets, and broiler prices are thus anticipated to follow similar trends as those of global markets. It is crucial to comprehend how the South African broiler market functions within the context of the worldwide markets since changes in those markets will have an impact on that country's broiler business. According to Davids (2013), the importation of cheaply produced broilers from South America has constrained domestic broiler prices and put pressure on the South African producer profit margins. Imports from Brazil and Argentina, which have a significant competitive advantage in producing broiler due to their substantially lower production costs and status as net exporters of maize and soy cake, broiler imports have a detrimental impact on domestic broiler prices.

The prices for both inputs and outputs have an impact on the agricultural supply. A rise in output prices raises profit, and a rise in profit encourages farmers to expand production. In a similar vein, rising input costs drive up production costs, which reduce incentives to increase output(Tripathi & Prasad, 2009). Broiler producers in South Africa respond very well to broiler prices in the long run as compared to short run and non-price factors that have a minimal impact on the supply of the broiler in the country. This is corroborated by Rao (2003), who asserts that agricultural pricing policy has a significant impact on farm income and productivity, and that, it is essential to comprehend this price mechanism in the supply response. If the broiler price is the only variable

that affects the supply response, it might be that there is a small subsidy by the government on the broiler industry in a form of non-price incentives and as such, the supply response will always be low. In the case of India, farmers were given numerous incentives and abolished many restrictions from the agrarian sector. Since independence, the Indian government has taken several steps to improve agriculture, including land reform, significant public investments in irrigation and rural electrification, strengthening of agricultural research and extension services, expansion and improvement of the transport network, particularly rural roads, and development of rural credit institutions. However, the supply response for Indian agriculture is still insufficient. The subject of "why is supply response low" thus becomes critical (Tripathi & Prasad, 2009). According to the results of the study, the supply response of the broiler in South Africa is mainly affected by the price of the broiler. The inelastic state of labp to lbs is a signal to broiler producers to increase prices to increase the total revenue and possibly maximise profits. Large import volumes from Brazil and nations in the Northern Hemisphere affect local pricing settings. These nations are among the best in producing broilers in the world. The technical performance of South Africa is at par with that of these nations. Local producers, however, fall behind if input costs are considered.

4.6 Chapter summary

In summary, the price of the broiler has a significant impact on the supply of the broiler, and this might be due to the production cycle of the broiler, as the returns from the previous cycle can influence the next cycle of production. However, broiler price is inelastic, meaning a 1% change in price results in a less proportionate increase in the supply of thebroiler. Diseases, particularly Avian Flu, result in mortality and that has a significant impact on the supply of the broiler. Other variables, such as broiler feed price index, broiler imports and exports and nominal exchange rate, have a significant impact on the supply of broiler. However, these variables as individuals are not significant to the supply of broiler meat in South Africa. Both price and non-price incentives are significant in the supply of broiler meat in South Africa. .

5 CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Key research conclusions and recommendations are summarised, and areas for additional research are identified in this chapter. This dissertation's core claim is that price incentives and non-price incentives may have an impact on how South African broiler producers respond in terms of supply. The idea of supply response focuses on the output-price relationships, and agricultural supply response models imply the modelling approach used to describe how producers allocate productive resources. Therefore, under certain assumptions, an agricultural response is dependent on ,causal variables and linkages. This chapter summarises the study's findings and potential implications. It also covers crucial areas for future research.

5.2 Summary

The broiler industry is highly integrated, and this makes it difficult for small growers to enter the industry. Because there are few participants in the value chain, competition at the retail level is very high. The sector was declared as a distressful sector by the Department of Trade and Industry in 2013, and several key stakeholders came together to propose solutions or remedial actions that could make the broiler industry sustainably competitive.

Based on the results of the study, broiler price is the key variable that affects the supply response of broiler producers in South Africa. Other variables included in the model have no significant impact on the supply response as individuals. However, collectively these variables have a significant impact on the supply response. Price and non-price factors have a significant impact on the supply of the broiler in South Africa.

5.3 Conclusion

This study considered the dynamics between the supply of the broiler and some explanatory variables comprising price and non-price factors. An effort was made for a logarithmic transformation of the model which provides insight into the nature of elasticity that characterises non-price factors.

However, the study concludes that weighted average broiler price (labp) is a crucial and significant variable that promotes the supply of the broiler in the long run, while a previous period supply of

the broiler depresses the current supply of the broiler. For instance, a unit increase in a previous supply of broiler is found to decrease the current supply of broiler by 0.7225 in the short- run. This study, therefore, establishes the interdependence of the current supply of the broiler with respect to what was obtainable in previous times. Therefore, broiler producers revise their current supply based on their previous experiences.

Moreover, the price elasticity of broiler with respect to the supply of broiler is found to be price inelastic thus denoting that the supply of broiler only increases less proportionately relative to the rise in broiler price in the long run. Besides, the previous supply of the broiler has an inelastic and negative effect on the current supply of the broiler, which results in the conclusion that a unit increase in the previous month's supply of broiler results in a less proportionate decrease in the current supply of the broiler. Broiler price and non-price factors are significant in terms of influencing the supply response by broiler producers in South Africa. Diseases were found to be significant in the short run. However, other variables in the model were found to be not significant as individuals, but collectively, they are significant. These include, the broiler feed price index, broiler imports and exports and the nominal exchange rate. Broiler price and diseases are key factors that influence the responsiveness of broiler producers to supply more quantities.

In conclusion, the local poultry business makes a substantial contribution to the South African agricultural sector and food security. However, it takes strong administrative and technological abilities to produce broiler meat for competitive prices in worldwide markets. When compared to their competitors abroad, the producers in South Africa also have to deal with ever-fluctuating feed prices. Maize and soybeans are the two main ingredients for feed in the South African chicken business, and both of these commodities' prices are substantially more variable in South Africa than in their worldwide counterparts. Imports tariffs only favour producers, and since broiler is the cheapest source of protein, it becomes imperative for the government to ensure that poor communities can afford to buy broiler to ensure food security.

5.4 Recommendations

The broiler industry has grown exponentially in terms of the demand for the broiler and the gross value. Though literature has indicated that the demand for the broiler has increased substantially, the local broiler producers could not produce adequately to meet the local demand, thus imports

played a central role in augmenting the local production. The local production of the broiler has been severely affected by the trade agreements. Imports have replaced the potential increase in local output. This is mostly because imports have entered our market at reduced prices. Many low-cost chicken items have entered our market as a result of market conditions and trade agreements. Domestic broiler prices have been under pressure, and the South African producers' market share has decreased. Consumers may have benefitted, but producers have not been able to spur the industry's expansion. At the same time, exports have not been able to make up for the difference.

In addressing these issues raised, the implementation of the Poultry Master Plan for South Africa is very crucial for the sustainability of the sector. Local production of broiler meat in South Africa must be expanded to increase the supply of broiler meat. Expansion of broiler production could be realised through private investment on the broiler industry. Unlocking entry barriers in the sector is very crucial to all new producers to enter the market as a way of improving local production.More contract growers must participate in the sector by supplying large companies. Contract grower model must be fully implemented as a practical way to integrate smallholder producers into the main value chain. This model will assist to lowers transaction costs and guarantees market access for growers and a consistent supply of inputs, which guarantees a consistent revenue as long as other conditions remain the same. Although it is significantly underreported, contract growing has been a very helpful type of transformation in the broiler sector. Due to the supported co-management approach and guaranteed market access, very few contract growing enterprises fail.

The other critical issue in the broiler industry is the production cost, mainly, the feed cost. Maize and soybean are the key ingredients that make 70% of the broiler feed. For the poultry industry to remain competitive, it must coordinate its production, make investments at all stages of the value chain, take advantage of economies of scale, and be able to afford the major raw materials. The government can consider strategies to boost the output of soybeans and maize, which are used as broiler feed.

Except major suppliers like Brazil and the USA, feed costs are still being driven up by the need to import protein meal, which is primarily made of soybean meal (Bureau for Food and Agricultural Policy, 2021). South Africa is the net exporter of maize. However, the country is the net importer of soybean and as such, soybean is traded at import parity price.

In terms of the low production of the soybean, more research must be conducted to explore the possibilities of increasing soybean production in the country. Besides, alternative ingredients that can supplement soybeans must also be discovered. Also, if South Africa cannot produce adequate soybeans, neighbouring countries can be approached for possible trade agreements if soybeans are produced in large quantities in their locality. These are policy imperatives that can be explored as a measure to reduce the feed cost of broilers in the country.

Due to the increase of broiler imports into the South African markets, the broiler sector finds it difficult to compete with low price levels of imports. Furthermore, South Africa is the main exporter of the broiler in the SADC and to ensure that the sector remains competitive, there has to be a market share increase in the exportation of the broiler in SADC countries. There is a need to increase broiler production and investment to allow the booming of the export market because certainly, the demand for the broiler is high at the global and regional levels. This has been supported by Food and Agriculture Organisation (2017), indicating that poultry meat is predicted to rise by 813 percent, making it the fastest-growing product in Africa between 2010 and 2050. It will be followed by hog, beef, and mutton and goat, which are predicted to grow by 573 percent, 261 percent, and 162 percent, respectively.

According to Molepo (2020), SADC nations are the final destination of the South African broiler exports. The bulk of consumers in this market like brown meat, and often, non-tariff trade barriers make doing business in SADC countries prohibitively expensive. For instance, since trucking accounts for the majority of intra-SADC trade, delayed border clearance acts as a significant non-tariff barrier. In ensuring that the broiler industry remains competitive, the exportation of the broiler is imperative to the growth of this sector. South Africa needs to ensure that it increases its export market share by increasing domestic production and addressing challenges around the transportation of the broiler to SADC countries. Non-tariff trade barriers such as non-compliance to sanitary and phytosanitary measures need to be attended to so that the market share in the EU can be increased. If the market share on broiler exports is increased, then the local broiler supply will increase, and the sector will remain competitive. In order to increase the potential market that rising producers can enter, the expansion of domestic production should be prioritized given the predicted growth in demand over the next ten years.

According to Ferro *et al.* (2015), higher standards, notably better SPS standards, are typically associated with higher affluent countries. This typically happens as a result of higher-income countries' levels of public awareness and concern about the quality of the food they consume. The literature has evidence showing that households with more money tend to buy better products. Therefore, as a country's income increases, standards tend to become more stringent and more demanding. It should also be thought about if exports could help to balance the domestic market. Recent exports of high-value goods, notably to the Middle Eastern markets, have helped the local cattle industry increase the value of the carcass. However, potential high-value product exports are reliant on sanitary and phytosanitary (SPS) regulations that must be followed, and the procedure for accessing new export markets can be time-consuming and difficult. Furthermore, according to the benchmark for production costs, South Africa would not be able to compete with other top exporters like Brazil and the USA, unless she is offered favourable shipping costs to its final destination or is granted privileged access to particular markets. In order to fulfill the standards of potential export markets, local producers must quickly find solutions to the health and safety issues that must be addressed. Government should play a crucial role in establishing the essential trade conditions for export.

According to Davids *et al.* (2015), and Nzimande and Ellerbeck (2014), the broiler market in South Africa is currently oversaturated with imports from other countries, and the lending price (cost of insurance and freight) is equal to or less than the domestic price. These imports discourage the local supply of broiler and as such, they dominate the local market. There is a need to revise the current broiler tariffs to protect the local market. These imports are likely to be receiving subsidies from their countries of origin. For instance, there are no import taxes applied to imports from the EU. Instead, a restricted 13.9 percent safeguard duty is in place to defend the indigenous industries against subsidised imports. Broiler meat brining regulations have been updated, and bone-in sections imported from the USA are now free from anti-dumping taxes. To sustain the broiler sector, the government with key stakeholders must heavily invest in the broiler sector to ensure food security for all, as broiler is the cheapest source of protein that majority of the population can afford as compared to other protein sources such as beef, fish and others.

According to Muhammad *et al.* (2014), fluctuating exchange rates can significantly impact bilateral trade flows. However, given the biological, marketing, and economic characteristics

unique to an item, this effect might vary across several industries. The article "The Impact of Exchange Rate Volatility on World Broiler Trade" by Davis *et al.* (2014) examines how exchange rate volatility affects cross-partner broiler trade and demonstrates that while this effect is negative and significant in the long run, it is minimal in comparison to the effects of population growth, regionalisation, and border sharing. Since broiler production is profitable, the government should give priority to supporting South African broiler producers to preserve and secure current jobs in the sector and also to guarantee that new jobs are created. To take advantage of the Free Trade Areas (FTA) policy, which permits zero tariffs on the intra-broiler exports, the government should support discussions with SADC countries.

Boosting local demand for broiler products by private and public sector. Government institutions and private companies should procure local products. This will strengthen local economy and more job opportunities will be created in the broiler industry.

To enable broiler farmers to produce successfully and sustainably so government must ensure that the environment is conducive given all the challenges in the sector. that they can aid in the facilitation of transition, it is crucial to create this environment.The government should be eager to hear about an success of the broiler industry. However, this will require enough support from the government and poultry sector partners to advance the sector and allow the industry to claim its position as one of the sectors to achieve government priority areas such as food security and employment creation.

5.5 Limitations of the study

Despite using some of the most effective techniques for assessing the agricultural supply response, nevertheless, this study managed to produce significant findings. However, it is crucial to note some of the significant research's limitations:

- Though the *r* -squared was 0.6379, certain data were not part of the research. This includes data on financial support to broiler producers by the government as a measure to expand the entry to the broiler industry. Credit should be a significant element in supply response because agricultural production also depends on the degree of private investment, but this is not the case because historical time series data were unavailable.

- Given the production cycle of the broiler, data obtained from SAPA was on monthly basis and as such, other variables could not be included in the model because of the frequency of data, which was quarterly and yearly.

- The study was limited to commercial broiler producers in South Africa. Small-scale broiler producers were not included in the study as their data were not part of the time series data collected from the South African Poultry Association (SAPA). Furthermore, data from small scale broiler producers is not published by Department of Agriculture, Land Reform and Rural Development

5.6 Implications for further studies

- Since broiler meat is the cheapest source of protein and affordable, research needs to be conducted to establish the influence of external factors on the pricing of the broiler in South Africa.
- Government has the responsibility to ensure that households are food-secured, and the broiler meat as the main source of protein is key. The extent to which the government policies support the production of broiler in South Africa is an area that needs to be explored as well.

- South Africa is the net exporter of the broiler in the SADC countries, thus there is a need to look at the possibilities to expand its market share and the measures that should be put in place to enhance these opportunities

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